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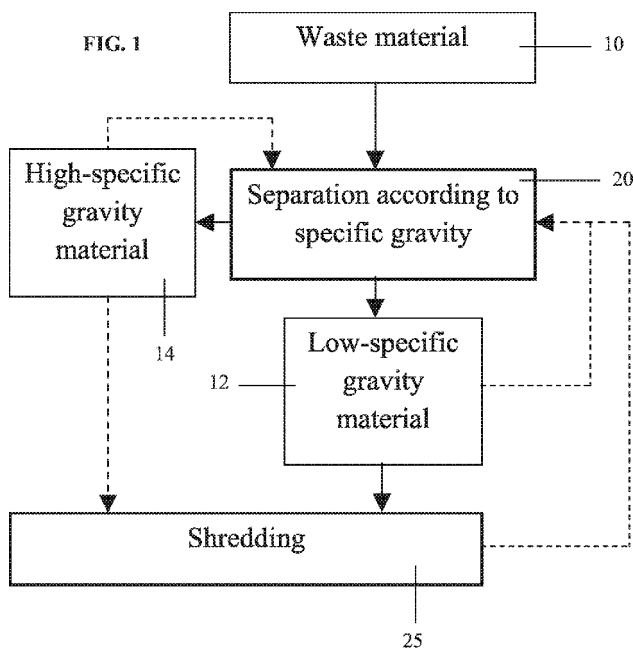
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(54) Title: METHOD OF SORTING AND/OR PROCESSING WASTE MATERIAL AND PROCESSED MATERIAL PRODUCED THEREBY



(57) Abstract: A method of sorting waste material is disclosed herein, the method comprising separating materials in the waste material according to specific gravity, by contacting the waste material with a liquid selected such that a portion of the waste material sinks, to thereby obtain a sorted material containing at least 90 weight percents of material having a specific gravity within a pre-selected range. Further disclosed herein is a method of processing waste material by separating materials in the waste material according to specific gravity as described herein to remove at least a portion of inorganic materials in the waste material, and subjecting a feedstock comprising the obtained sorted material to mixing via shear forces and to heating. Further disclosed herein are a polymeric material obtainable by the method of processing waste material, articles-of-manufacturing comprising same, and systems for sorting and processing waste material.

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METHOD OF SORTING AND/OR PROCESSING WASTE MATERIAL AND
PROCESSED MATERIAL PRODUCED THEREBY

5 FIELD AND BACKGROUND OF THE INVENTION

The present invention, in some embodiments thereof, relates to waste treatment and, more particularly, but not exclusively, to methods and systems for sorting and/or processing waste material and processed material produced thereby.

10 The most common method of disposing of waste material is deposition in landfills. However, environmental concerns and/or the cost of land may render this method unsatisfactory.

Standard recycling of waste material typically requires sorting of waste material into different types of material, and recycling or discarding the different types of material separately.

15 An alternative to standard recycling is production of refuse-derived fuel (RDF) by shredding and dehydrating solid waste material, and combustion of the RDF in power plants.

U.S. Patent No. 6,017,475 describes a process of converting household garbage into useful byproducts by reducing the garbage to an aggregate shard, optionally
20 expelling liquid from the aggregate shard, and heating the aggregate shard under pressure to create a pulp. A system comprising a grinder for converting household garbage to an aggregate shard, and a hydrolyzer for decomposing the remaining aggregate shard after the liquid has been removed, to form the pulp, is also described. The process hydrolyzes lignocellulose in the garbage, to obtain an aggregate cellulose
25 pulp having traces of metals and plastics. As further described therein, the aggregate cellulose pulp can be separated into pure cellulose pulp and a residue containing inorganic materials.

U.S. Patent No. 7,497,335 describes “hydrogravity” separation of a multiple domain solid feedstock to produce particles of each substantially a single domain, each
30 type of particle having a different density. Particles are slurried into a suitable fluid to effect binary separation of the mixture of particles into a stream with a higher average specific gravity and a stream with a lower average specific gravity.

International Patent Application having Publication No. WO 2006/035441 describes a method of encapsulating pieces of waste with melted plastic by heating and mixing.

International Patent Application having Publication No. WO 2010/082202
5 describes a composite material prepared by drying waste, and heating the dried waste while mixing under shear forces. The composite material has thermoplastic properties, and is processed to obtain useful articles.

Additional background art includes International Patent Applications having Publication Nos. WO 2005/077630, WO 2005/092708 and WO 2006/079842; European
10 Patent No. 1711323; KR 2003/0014929; U.S. Patent Nos. 3,850,771, 4,013,616, 4,772,430, 4,968,463, 5,217,655, 6,017,475, 6,253,527 and 6,423,254; and U.S. Patent Applications having Publication Nos. 2004/0080072 and 2004/0080072.

SUMMARY OF THE INVENTION

15 According to an aspect of some embodiments of the invention, there is provided a method of processing waste material so as to form a non-particulate processed material.

According to some embodiments, the method comprises:

removing at least a portion of inorganic materials in the waste material, to
20 thereby obtain a sorted material containing at least 90 weight percents of an organic material;

providing a feedstock having a water content of at least 15 weight percents, wherein at least 50 weight percents of the dry weight of the feedstock is the sorted material;

25 subjecting the feedstock to mixing via shear forces; and

subjecting the feedstock to heating, thereby obtaining a non-particulate processed material.

According to some embodiments, the removing comprises separating materials according to specific gravity, the separating comprising contacting the waste material
30 with a liquid selected such that at least a portion of inorganic materials sink; and

the feedstock is subjected to the mixing and the heating without being dried.

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According to an aspect of some embodiments of the invention, there is provided a method of sorting waste material, the method comprising:

5 separating materials in the waste material according to specific gravity, the waste material being solid waste comprising a mixture of wood-derived materials, plastics, food and inorganic materials, said separating comprising contacting the waste material with an aqueous liquid selected such that a portion of said waste material sinks, to thereby obtain a sorted material containing at least 90 weight percents of material having a specific gravity within a pre-selected range, wherein said aqueous liquid comprises an aqueous salt solution, and a concentration of the salt in said aqueous salt solution is at least 10 weight percent.

10 According to an aspect of some embodiments of the invention, there is provided a polymeric material obtainable by a method of processing waste material described herein.

According to an aspect of some embodiments of the invention, there is provided an article-of-manufacturing formed from the polymeric material described herein.

According to an aspect of some embodiments of the invention, there is provided a use of a waste material for the production of the article-of-manufacturing described herein.

15 According to an aspect of some embodiments of the invention, there is provided a system for processing a waste material to form a non-particulate processed material.

According to some embodiments, the system comprises:

20 a separator configured for removing at least a portion of inorganic materials from the waste material by separating materials in the waste material according to specific gravity, the separator containing a liquid selected such that at least a portion of inorganic materials sink, to thereby provide a sorted material containing at least 90 weight percents of an organic material;

25 an apparatus for subjecting a feedstock to mixing via shear forces, the apparatus comprising a first mixing zone and a second mixing zone, each independently being adapted for subjecting the waste material to heating; and

a first vent and a second vent, each being adapted for removing gases released during the mixing and the heating from the apparatus,

the system being configured for providing to the apparatus a feedstock comprising the sorted material, and having a water content of at least 15 weight percents, and

30 the apparatus being configured for subjecting the feedstock to mixing in the first mixing zone and removing gases from the first vent, and subsequently subjecting the

feedstock to mixing in the second mixing zone and removing gases from the second vent, to thereby obtain a processed material, wherein the feedstock is subjected to the mixing and the heating without being dried.

According to an aspect of some embodiments of the invention, there is provided a system for sorting a waste material, the system comprising:

a separator configured for separating materials in the waste material according to specific gravity, the separator containing a liquid selected such that a portion of said waste material sinks, to thereby obtain a sorted material containing at least 90 weight percents of material having a specific gravity within a pre-selected range, wherein said liquid comprises an aqueous salt solution, and a concentration of the salt in said aqueous salt solution is at least 15 weight percent; and

an apparatus configured for separating at least a portion of liquid from said sorted
5 material by compression.

According to some embodiments of the invention, at least 90 weight percents of the dry weight of the feedstock is the sorted material.

According to some embodiments of the invention, at least 99 weight percents of the dry weight of the feedstock is the sorted material.

10 According to some embodiments of the invention, less than 10 % of a volume of the non-particulate processed material consists of particles having a volume of at least 0.2 mm³.

According to some embodiments of the invention, separating materials according to specific gravity comprises obtaining a sorted material containing at least 90 weight
15 percents of material having a specific gravity within a pre-selected range.

According to some embodiments of the invention, separating materials according to specific gravity further comprises removing at least a portion of a polymer selected from the group consisting of a thermoset polymer and a synthetic polymer having a melting point of at least 250 °C in the waste material, to thereby obtain a sorted material containing
20 at least 90 weight percents of an organic material other than the thermoset polymer and the synthetic polymer having a melting point of at least 250 °C.

According to some embodiments of the invention, the water content of the feedstock is at least 40 weight percents.

According to some embodiments of the invention, the water content of the feedstock ranges from 50 to 70 weight percents.

According to some embodiments of the invention, at least 70 weight percents of the dry weight of the feedstock is lignocellulose.

5 According to some embodiments of the invention, no more than 95 weight percents of the dry weight of the feedstock is lignocellulose.

According to some embodiments of the invention, no more than 5 weight percents of the dry weight of the feedstock is inorganic material.

10 According to some embodiments of the invention, from 15 to 30 weight percents of the dry weight of the feedstock comprises synthetic polymers.

According to some embodiments of the invention, at least 50 weight percents of synthetic polymers in the feedstock is polyolefins.

According to some embodiments of the invention, at least 1 weight of the dry weight of the feedstock is inorganic salts.

15 According to some embodiments of the invention, the mixing and the heating are performed until a water content of the processed material is less than 1 weight percent.

20 According to some embodiments of the invention, the method further comprises contacting the waste material or sorted material with an acidic substance, to thereby provide the feedstock.

According to some embodiments of the invention, the acidic substance comprises hydrochloric acid.

According to some embodiments of the invention, the acidic substance comprises an aqueous solution characterized by a pH of less than 4.

25 According to some embodiments of the invention, the method further comprises mixing the sorted material with an additional material, to thereby provide the feedstock.

According to some embodiments of the invention, the additional material comprises at least one carbohydrate.

30 According to some embodiments of the invention, the processed material comprises a polymeric material.

According to some embodiments of the invention, a concentration of carbon in the processed material is at least 55 weight percents.

According to some embodiments of the invention, a concentration of oxygen in the processed material is at least 20 weight percents.

According to some embodiments of the invention, a total concentration of carbon and oxygen in the processed material is at least 80 weight percents.

5 According to some embodiments of the invention, a total concentration of carbon, hydrogen and oxygen in the processed material is at least 90 weight percents.

According to some embodiments of the invention, a total concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms in the processed material is at least 93 weight percents.

10 According to some embodiments of the invention, at least 95 percent of the non-hydrogen atoms in the processed material are carbon or oxygen atoms.

According to some embodiments of the invention, at least 97 percent of the non-hydrogen atoms in the processed material are carbon, oxygen, nitrogen, alkali metal or halogen atoms.

15 According to some embodiments of the invention, a molar concentration of alkali metals in the processed material is at least 50 % higher than a molar concentration of alkali metals in the dry weight of the waste material.

According to some embodiments of the invention, a molar concentration of halogens in the processed material is at least 50 % higher than a molar concentration of halogens in the dry weight of the waste material.

20 According to some embodiments of the invention, the waste material is a shredded waste material.

According to some embodiments of the invention, the method further comprises shredding the waste material prior to contacting the waste material with the liquid.

25 According to some embodiments of the invention, the method further comprises shredding the sorted material subsequent to contacting the waste material with the liquid.

According to some embodiments of the invention, the method comprises contacting the waste material with an aqueous liquid, to thereby obtain a partially sorted material, and further comprises subjecting the partially sorted material to at least one additional cycle of separating materials according to specific gravity, the separating

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comprising contacting the partially sorted material with an additional liquid, to thereby obtain the sorted material.

According to some embodiments of the invention, the method further comprises shredding the sorted material subsequent to contacting the partially sorted material with the additional liquid.

According to some embodiments of the invention, at least one of the at least one additional cycle of separating materials according to specific gravity comprises removing material which sinks in the additional liquid.

According to some embodiments of the invention, at least one of the at least one additional cycle of separating materials according to specific gravity comprises removing material which floats in the additional liquid.

According to some embodiments of the invention, the method further comprises separating at least a portion of oils from the sorted material.

According to some embodiments of the invention, the polymeric material described herein is a thermoplastic polymeric material.

According to some embodiments of the invention, the polymeric material described herein is characterized by a density below 1.2 gram/cm³.

According to some embodiments of the invention, a concentration of carbon in the polymeric material is at least 55 weight percents.

According to some embodiments of the invention, a concentration of oxygen in the polymeric material is at least 20 weight percents.

According to some embodiments of the invention, a total concentration of carbon and oxygen in the polymeric material is at least 80 weight percents.

According to some embodiments of the invention, a total concentration of carbon, hydrogen and oxygen in the polymeric material is at least 90 weight percents.

According to some embodiments of the invention, a total concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms in the polymeric material is at least 93 weight percents.

According to some embodiments of the invention, at least 95 percent of the non-hydrogen atoms in the polymeric material are carbon or oxygen atoms.

According to some embodiments of the invention, at least 97 percent of the non-hydrogen atoms in the polymeric material are carbon, oxygen, nitrogen, alkali metal or halogen atoms.

According to some embodiments of the invention, a molar concentration of
5 alkali metals in the polymeric material is at least 50 % higher than a molar concentration of alkali metals in the dry weight of the waste material.

According to some embodiments of the invention, a molar concentration of halogens in the polymeric material is at least 50 % higher than a molar concentration of halogens in the dry weight of the waste material.

10 According to some embodiments of the invention, a melt-flow index of the polymeric material is at least 1 gram per 10 minutes at a temperature of 190 °C.

According to some embodiments of the invention, the article-of-manufacturing comprises two or more materials adhered to and/or blended with one another, wherein at least one of the materials is the polymeric material described herein.

15 According to some embodiments of the invention, at least one of the two or more materials in the article-of-manufacturing is a plastic.

According to some embodiments of the invention, the system comprises at least one separator configured for separating materials in the waste material according to specific gravity, the at least one separator being configured for obtaining a sorted
20 material containing at least 90 weight percents of a material having a specific gravity within a pre-selected range.

According to some embodiments of the invention, the system is configured for removing at least a portion of a polymer selected from the group consisting of a thermoset polymer and a synthetic polymer having a melting point of at least 250 °C
25 from the waste material, to thereby obtain a sorted material containing at least 90 weight percents of an organic material other than the thermoset polymer and the synthetic polymer having a melting point of at least 250 °C.

According to some embodiments of the invention, the first mixing zone and the second mixing zone are each independently adapted for heating the feedstock at a
30 temperature in a range of from 90 °C to 230 °C.

According to some embodiments of the invention, the system further comprises a sensor for determining a water content of material in the apparatus described herein.

According to some embodiments of the invention, the apparatus comprises a screw for effecting the mixing.

According to some embodiments of the invention, the system is configured for contacting the waste material or sorted material with an acidic substance.

5 According to some embodiments of the invention, the system is configured for mixing the sorted material and/or the processed material with an additional material.

According to some embodiments of the invention, the system further comprises a shredder configured for shredding the waste material prior to contacting the waste material with the liquid.

10 According to some embodiments of the invention, the system further comprises a shredder configured for shredding the sorted material subsequent to contacting the waste material with the liquid.

According to some embodiments of the invention, the system further comprises a monitor for monitoring a specific gravity of the liquid in the separator, wherein the system is configured to adjust a specific gravity of the liquid in the separator to a predetermined value.

15 According to some embodiments of the invention, the system comprises a first separator configured for separating materials according to specific gravity to thereby obtain a partially sorted material, and at least one additional separator configured for subjecting the partially sorted material to at least one additional cycle of separating materials according to specific gravity, the additional separator containing an additional liquid selected such that a portion of the partially sorted material sinks.

20 According to some embodiments of the invention, the system further comprises a shredder configured for shredding the sorted material subsequent to contacting the partially sorted material with the additional liquid in the additional separator.

25 According to some embodiments of the invention, a specific gravity of the liquid is at least 1.05.

According to some embodiments of the invention, the liquid comprises an aqueous salt solution.

30 According to some embodiments of the invention, the salt is sodium chloride.

According to some embodiments of the invention, a concentration of the salt in the aqueous salt solution is at least 10 weight percents.

According to some embodiments of the invention, a water content of the processed material is less than 1 weight percent.

According to some embodiments of the invention, the pre-selected range is no more than 1.25.

5 According to some embodiments of the invention, the system further comprises at least one apparatus configured for separating oils from said liquid.

Embodiments of the present invention encompass any combination of any of the embodiments described herein, unless otherwise indicated.

Unless otherwise defined, all technical and/or scientific terms used herein have
10 the same meaning as commonly understood by one of ordinary skill in the art to which the invention pertains. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary methods and/or materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and
15 examples are illustrative only and are not intended to be necessarily limiting.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the
20 drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.

In the drawings:

25 FIG. 1 is a flow chart depicting a method of separating waste material according to some embodiments of the invention;

FIG. 2 is a flow chart depicting a method of processing sorted waste material according to some embodiments of the invention;

30 FIG. 3 is a scheme depicting a system for separating and processing waste material according to some embodiments of the invention;

FIG. 4 is a scheme depicting a system for processing waste material according to some embodiments of the invention (large arrow shows direction of waste material; small arrows show direction of released gases);

FIGs. 5A and 5B are images of a cylindrical sample of extruded processed material according to some embodiments of the invention (side view FIG. 5A; cross-section FIG. 5B; diameter of sample is approximately 10 cm);

FIG. 6 is a graph showing heat flow as a function of temperature during a calorimetry scan (at a rate of 10 °C per minute) of a processed material according to some embodiments of the invention, as well as the temperature of observed phase transitions (represented by peaks) and heat of phase transitions;

FIG. 7 shows an infra-red spectrum of processed material prepared from waste material with (green) and without (blue) separation of the waste material according to some embodiments of the invention;

FIG. 8 is a graph presenting an electron paramagnetic resonance (EPR) spectrum of a processed material according to some embodiments of the invention, including peaks representing g1, g2 and g3 values; locations of a peak representing g values of 2.0 (characteristic of carbon radical) and 3.4 (characteristic of cellulose) are also shown;

FIGs. 9A and 9B present portions of an NMR spectrum (at different y-axis scales) of a processed material according to some embodiments of the invention;

FIGs. 10A and 10B show NMR spectra of a filtrate of sea salt aqueous solution (about 20 weight percents) (FIG. 10A) and fresh water (FIG. 10B), each filtrate being obtained after 3 hours incubation with plant biomass;

FIG. 11 is a scheme depicting a system for separating waste material according to some embodiments of the invention; and

FIG. 12 is a scheme depicting a system for separating and processing waste material according to some embodiments of the invention.

DESCRIPTION OF SPECIFIC EMBODIMENTS OF THE INVENTION

The present invention, in some embodiments thereof, relates to waste treatment and, more particularly, but not exclusively, to methods and systems for sorting and/or processing waste material and waste material produced thereby.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings and/or the Examples. The invention is capable of other embodiments or of being practiced or carried out in various ways.

The present inventor has uncovered that separating materials in a waste material according to specific gravity can be used to obtain, in an efficient and cost-effective manner, a sorted material useful for further processing without drying the sorted material. The present inventor has further uncovered that separation according to specific gravity can beneficially affect both the process progress and parameters and properties of the obtained processed material. For example, contacting waste materials (e.g., unsorted waste materials) with a liquid such as an aqueous solution can be utilized to advantageously separate some materials, particularly inorganic materials, from the obtained sorted materials and/or to increase a water content to a level particularly suitable for processing. Furthermore, separation by contacting waste materials with a liquid may be readily performed using wet waste material (e.g., waste material that has not been dried), whereas wet waste material poses an obstacle to other separation techniques, for example, by resulting in fragments of different types of material sticking to one another. The present inventor has further demonstrated that the processed waste material, obtained upon specific gravity separation, exhibits exceptional and controllable properties.

Referring now to the drawings, FIG. 1 illustrates a general procedure for separating waste material according to specific gravity, according to exemplary embodiments of the invention, as described in detail in the Examples section that follows.

FIG. 2 illustrates a general procedure for processing a sorted material, according to exemplary embodiments of the invention, as described in detail in the Examples section that follows.

FIG. 3 illustrates a system for separating and processing a waste material, according to exemplary embodiments of the invention, as described in detail herein under. FIG. 4 illustrates a system for processing a material (e.g., a sorted material),

according to exemplary embodiments of the invention, as described in detail herein under.

FIGs. 5A and 5B show a relatively homogeneous processed material produced according to exemplary embodiments of the invention.

5 FIGs. 6-9B show physical properties of processed material produced according to exemplary embodiments of the invention, as described in detail in the Examples section that follows.

FIGs. 10A and 10B show that hypertonic solution facilitates release of carbohydrates from biomass.

10 FIG. 11 illustrates a system for separating waste material according to specific gravity, according to exemplary embodiments of the invention, as described in detail herein under.

FIG. 12 illustrates a system for separating waste material according to specific gravity and processing the obtained sorted material, according to exemplary
15 embodiments of the invention, as described in detail in the Examples section that follows.

According to an aspect of some embodiments of the present invention, there is provided a method of sorting waste material, to thereby obtain a sorted material. In some embodiments, the method according to this aspect of the present invention is
20 effected by separating materials in the waste material according to specific gravity. In some embodiments, separating is effected by contacting the waste material with a liquid selected such that a portion of the waste material sinks in the liquid (and another portion does not sink).

Herein throughout, the phrase “waste material” refers to substantially solid
25 waste, such as municipal solid waste, which, in some embodiments, is obtained mostly from domestic sources, and is also referred to as “trash” or “garbage”. The phrase “waste material” as used herein encompasses substantially unsorted waste material (e.g., prior to removal of a portion of the materials as described herein), that is, it comprises a wide variety of substances typical of domestic waste, and optionally further
30 encompasses waste material, as defined herein, which has undergone some sorting (e.g., removal of readily recyclable items).

Thus, the waste material may optionally be in the form it is received at a solid waste management facility or at a waste dump or from a landfill (referred to as "unsorted" waste material), or alternatively, waste material which has undergone preliminary sorting, that is, waste material (e.g., from the aforementioned sources) from which one or more components (e.g., magnetic materials) are selectively removed (partially or entirely) before further sorting according to the method described herein. The waste material may include some waste from non-domestic sources, such as sludge (e.g., sewage sludge), industrial waste (e.g., discarded packaging material) and/or agricultural waste.

The waste material typically comprises some liquid (e.g., water, oils), for example, liquids absorbed by the waste material and/or within containers in the waste material. It is to be appreciated that the method of sorting described herein is effected by contact with a liquid, so that the waste material can therefore optionally be sorted without any need for prior drying of the waste material.

Herein throughout, the phrase "sorted material" is used to describe a material obtained by removing a portion of materials in a source material (e.g., a waste material) so as to obtain a material having a different composition than the source material. By "source material" it is meant, for example, the waste material as described herein, which is subjected to the sorting as described herein.

Herein throughout, the term "sorting" and grammatical derivations thereof is used to describe a process of obtaining a sorted material, as defined herein, from a source material (e.g., a waste material), as defined herein.

Herein throughout, the term "processing" and grammatical derivations thereof, in the context of an act performed on a material (e.g., waste material), is used to describe alteration of the composition, chemical properties and/or physical properties of the material, to thereby obtain a different, second material, referred to herein as "processed material", having a different composition, chemical properties and/or physical properties than the material subjected to processing. The term "processing" as used herein encompasses sorting, as defined herein, but is not limited to sorting.

For the sake of clarity, the term "processing material" is generally used herein to describe a material obtained by procedures other than sorting (whereas a material

obtained by sorting is referred to as “sorted material”), for example, by subjecting a sorted material (as defined herein) to processing other than sorting (e.g., heating).

In some embodiments of this aspect of the present invention, the method provides a sorted material enriched in material having a specific gravity within a pre-selected range, and the liquid is selected in accordance with the pre-selected range (e.g.,
5 selection of a suitable concentration for an aqueous salt solution, as discussed in further detail herein below).

In some embodiments of any of the embodiments described herein, the sorted material contains at least 90 weight percents of material having a specific gravity within a pre-selected range. In some embodiments, the sorted material contains at least 95
10 weight percents of material having a specific gravity within a pre-selected range. In some embodiments, the sorted material contains at least 98 weight percents of material having a specific gravity within a pre-selected range. In some embodiments, the sorted material contains at least 99 weight percents of material having a specific gravity within
15 a pre-selected range. Any value between 90 and 99.9 weight percents is also contemplated according to these embodiments.

As used herein, the term “specific gravity” refers to a ratio of density of a material to a density of pure water under the same conditions (e.g., temperature, pressure). Thus, the specific gravity of pure water is defined as 1. In some embodiments
20 of any of the embodiments described herein, the specific gravity is a specific gravity at room temperature (e.g., 25 °C) and atmospheric pressure. However, because specific gravity is a ratio, it is less sensitive than density to changes in conditions (e.g., temperature, pressure). Hence, in some embodiments of any of the embodiments described herein, the specific gravity is a specific gravity under working conditions.
25 For example, ambient temperature under working conditions may vary, for example, within a range of about 0 °C to 50 °C, and ambient pressure may vary according to altitude of the location.

A pre-selected range for the specific gravity may optionally be characterized by an upper limit and a lower limit, or alternatively, the range may optionally be an open-ended range, for example, characterized by an upper limit with no lower limit, or by a
30 lower limit with no upper limit.

In some embodiments of any of the embodiments described herein, the pre-selected range is no more than 1.25, that is, the upper limit of the pre-selected range is no more than 1.25, such that the entire range is no more than 1.25. In some embodiments, the pre-selected range is no more than 1.225. In some embodiments, the pre-selected range is no more than 1.20. In some embodiments, the pre-selected range is no more than 1.175. In some embodiments, the pre-selected range is no more than 1.15. In some embodiments, the pre-selected range is no more than 1.125. In some embodiments, the pre-selected range is no more than 1.10.

In some embodiments of any of the embodiments described herein, the sorted material is enriched (relative to the waste material from which it is derived) in material having a specific gravity below a specific gravity of the liquid. In some of these embodiments, the method is effected by removing materials which sink in the liquid from the waste material, to thereby obtain the sorted material.

In some embodiments of any of the embodiments described herein, the sorted material is enriched (relative to the waste material from which it is derived) in material having a specific gravity above a specific gravity of the liquid. In some of these embodiments, the method is effected by removing materials which do not sink in the liquid from the waste material, to thereby obtain the sorted material.

In some embodiments of any of the embodiments described herein, the sorted material is enriched (relative to the waste material from which it is derived) in material having a specific gravity below a specific gravity of a first liquid (e.g., an aqueous salt solution) and above a specific gravity of a second liquid (e.g., water or a dilute aqueous salt solution). In some of these embodiments, the method comprises a stage of removing materials which sink in the first liquid from the waste material, as well as a stage of removing materials which do not sink in the second liquid from the waste material.

Herein, the term "sink" encompasses sinking to a bottom of a liquid (e.g., sedimenting), as well as sinking below a surface of the liquid.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, at least a portion of the inorganic materials of a waste material (which are frequently denser than organic materials) sink to a bottom of the liquid.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, materials which sink to the bottom are removed (e.g., by removing sediment), and substantially all other materials are collected.

5 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, materials which float in the liquid are collected (e.g., by skimming a surface of the liquid), and substantially all other materials are removed.

10 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, separation of waste material comprises removing substantially all of the material from the liquid (e.g., both the collected sorted material and the material removed from the waste material in order to obtain the sorted material removed from the liquid), such that the liquid can be reused to separate more waste material according to specific gravity. Removal from the liquid can be for example, by skimming floating material from a surface, removing sedimented material, and/or filtering out material which sinks below a surface of the liquid but does not sink to the
15 bottom.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the waste material is stirred in the liquid, for example, by rotation of at least one paddle (e.g., rotation of a paddle wheel). Stirring is optionally selected to be sufficiently vigorous to facilitate separation of different types of material
20 (which may be stuck to one another, for example), while being sufficiently gentle to allow separation of materials in the liquid.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, stirring comprises perturbation (e.g., rotation, vibration, agitation) at a frequency of 120 per minute or less. In some embodiments, stirring
25 comprises perturbation at a frequency of 60 per minute or less. In some embodiments, stirring comprises perturbation at a frequency of 30 per minute or less. In some embodiments, stirring comprises perturbation at a frequency of 20 per minute or less. In some embodiments, stirring comprises perturbation at a frequency of 10 per minute or less.

30 The liquid may be any type of liquid, including a pure liquid, a solution, and a suspension.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the liquid is an aqueous liquid.

As used herein, the phrase “aqueous liquid” refers to a liquid in which at least 50 weight percents of the liquid compound(s) therein (e.g., excluding solid materials suspended and/or dissolved in the liquid) is water. In some embodiments, at least 60 weight percents is water. In some embodiments, at least 70 weight percents is water. In some embodiments, at least 80 weight percents is water. In some embodiments, at least 90 weight percents is water. In some embodiments, at least 95 weight percents is water. In some embodiments, at least 98 weight percents is water. In some embodiments, at least 99 weight percents is water. In some embodiments, the liquid component substantially consists of water.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the liquid is a solution, for example, an aqueous solution. Suitable solutes for a solution (e.g., an aqueous solution) include water-soluble salts, that is, any compound which form ions in water (e.g., sodium chloride, potassium chloride, sodium bromide, potassium bromide, calcium chloride, calcium nitrate, potassium carbonate) and water-soluble carbohydrates (e.g., glucose, sucrose, lactose, fructose).

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the solute is a salt, that is, the liquid is an aqueous salt solution (solution of ions). In some embodiments the salt comprises sodium chloride. The sodium chloride may optionally be substantially pure. Alternatively, the sodium chloride is mixed with other salts, for example, as in sea salt.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the liquid comprises sea water (e.g., sea water diluted with fresh water and/or concentrated sea water, that is, sea water from which a portion of the water has been removed). In some embodiments, the liquid consists essentially of sea water.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the liquid is a suspension, for example, an aqueous suspension. Suitable suspended materials for a suspension include water-insoluble salts and/or metallic substances, such as, for example, calcium carbonate, iron powder and

ferrosilicon (FeSi). In some embodiments, the suspended material is magnetic, which facilitates removal its removal from separated waste materials (e.g., for reuse).

The specific gravity may be selected in accordance with the materials which are desired to be separated from the waste material and/or with the materials which are
5 desired to be retained in the waste material (e.g., for further processing).

The specific gravity of a solution or a suspension can be finely controlled in accordance with the separation requirements, by controlling the concentration of the solute or suspended material.

Thus, for example, if it is desired to separate only materials with are
10 characterized by high specific gravity, a solution or suspension with a relatively high specific gravity (yet lower than that of the materials to be separated) is to be used, and therefore, a high concentration of the solute or suspended material is included.

If it is desired to retain in the waste material only materials which have a specific gravity that is lower or is the same as that of water (e.g., organic materials), a
15 solution or suspension with a specific gravity that is slightly above that of water is to be used, and therefore, a relatively low concentration of the solute or suspended material in included.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, a specific gravity of the liquid is in a range of from 1.00 to
20 2.50.

A specific gravity of up to 2.50 may be suitable, for example, for removing all or almost all inorganic materials which may be present in the waste material. Thus, for example, window glass has a specific gravity of approximately 2.58, silica has a specific gravity of approximately 2.65, aluminum has a specific gravity of
25 approximately 2.7, and specific gravities of other minerals and metals are typically even higher. In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 2.00, for example, in a range of from 2.00 to 2.50. A specific of at least 2.00 may be suitable, for example, for retaining all or almost all organic materials, such as plant materials, animal
30 materials, and polymeric materials (e.g., rubber and plastics).

Herein, "animal material" refers to material which originates from an animal, and "plant material" refers to material which originates from a plant or fungus. It is

noted that coal and petroleum products and the like, which originate from organisms which lived only in the distant past, are not considered herein as animal or plant material.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.50, for example, in a range of from 1.50 to 2.00. A specific gravity of at least 1.50 may be suitable, for retaining a large majority of organic materials. In some embodiments, the specific gravity is at least 1.60. In some embodiments, the specific gravity is at least 1.70. In some embodiments, the specific gravity is at least 1.80. In some embodiments, the specific gravity is at least 1.90.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.20, for example, in a range of from 1.20 to 1.50. A specific gravity of at least 1.20 may be suitable, for retaining many or even most organic materials, while removing some organic materials (e.g., synthetic polymers). In some embodiments, the specific gravity of the liquid is at least 1.25. In some embodiments, the specific gravity of the liquid is at least 1.30. In some embodiments, the specific gravity of the liquid is at least 1.35. In some embodiments, the specific gravity of the liquid is at least 1.40. In some embodiments, the specific gravity of the liquid is at least 1.45.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.01, for example, in a range of from 1.01 to 1.20. A specific gravity in a range of 1.01 to 1.20 may be suitable, for retaining many or even most animal materials and plant materials, while removing many synthetic polymers, such as thermoset polymers, synthetic polymers having a melting point of at least 250 °C (e.g., polyethylene terephthalate (PET), polytetrafluoroethylene (PTFE)) and polyvinyl chloride (PVC).

Herein, the term “thermoset” refers to a synthetic polymer that has been irreversibly cured by any technique, including curing by heating, by chemical reaction (e.g., as in epoxies) or irradiation. Examples of thermoset polymers include, without limitation, thermoset polyesters (e.g., as used in fiberglass), polyurethanes, vulcanized rubbers, phenol-formaldehydes (e.g., Bakelite® polymer), Duroplast, urea-

formaldehydes (e.g., as used in plywood), melamine resins, epoxy resins, polyimides, cyanate esters and polycyanurates.

Without being bound by any particular theory, it is believed that reducing a proportion of thermoset polymers, synthetic polymers having a high melting point (e.g.,
5 at least 250 °C) and/or PVC in an obtained sorted material renders the sorted material more amenable to processing (e.g., as described herein). It is further believed that separation according to specific gravity, as described herein, is a particularly convenient method for obtaining a sorted material with a reduced proportion of such polymers relative to a waste material from which the sorted material is derived.

10 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is no more than about 1.25 (e.g., about the specific gravity of a saturated aqueous solution of sea salt). In some embodiments, the specific gravity is no more than 1.20. In some embodiments, the specific gravity is no more than 1.15.

15 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.05. In some embodiments, the specific gravity is in a range of from 1.05 to 1.25. In some embodiments, the specific gravity is in a range of from 1.05 to 1.20. In some embodiments, the specific gravity is in a range of from 1.05 to 1.15.

20 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.06. In some embodiments, the specific gravity is in a range of from 1.06 to 1.25. In some embodiments, the specific gravity is in a range of from 1.06 to 1.20. In some embodiments, the specific gravity is in a range of from 1.06 to 1.15.

25 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.07 (e.g., an aqueous sodium chloride solution at a concentration of about 10 weight percents). In some embodiments, the specific gravity is in a range of from 1.07 to 1.25. In some embodiments, the specific gravity is in a range of from 1.07 to 1.20. In some
30 embodiments, the specific gravity is in a range of from 1.07 to 1.15.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.08. In some

embodiments, the specific gravity is in a range of from 1.08 to 1.25. In some embodiments, the specific gravity is in a range of from 1.08 to 1.20. In some embodiments, the specific gravity is in a range of from 1.08 to 1.15.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.09. In some
5 embodiments, the specific gravity is in a range of from 1.09 to 1.25. In some embodiments, the specific gravity is in a range of from 1.09 to 1.20. In some embodiments, the specific gravity is in a range of from 1.09 to 1.15.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.10. In some
10 embodiments, the specific gravity is in a range of from 1.10 to 1.25. In some embodiments, the specific gravity is in a range of from 1.10 to 1.20. In some embodiments, the specific gravity is in a range of from 1.10 to 1.15.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.11 (e.g., an
15 aqueous sodium chloride solution at a concentration of about 15 weight percents). In some embodiments, the specific gravity is in a range of from 1.11 to 1.25. In some embodiments, the specific gravity is in a range of from 1.11 to 1.20.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.12. In some
20 embodiments, the specific gravity is in a range of from 1.12 to 1.25. In some embodiments, the specific gravity is in a range of from 1.12 to 1.20.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.13. In some
25 embodiments, the specific gravity is in a range of from 1.13 to 1.25. In some embodiments, the specific gravity is in a range of from 1.13 to 1.20.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.14. In some
30 embodiments, the specific gravity is in a range of from 1.14 to 1.25. In some embodiments, the specific gravity is in a range of from 1.14 to 1.20.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.15 (e.g., an

aqueous sodium chloride solution at a concentration of about 20 weight percents). In some embodiments, the specific gravity is in a range of from 1.15 to 1.25. In some embodiments, the specific gravity is in a range of from 1.15 to 1.20.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.175. In some
5 embodiments, the specific gravity is in a range of from 1.175 to 1.25. In some embodiments, the specific gravity is in a range of from 1.175 to 1.20.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is at least 1.20. In some
10 embodiments, the specific gravity is in a range of from 1.20 to 1.25.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the specific gravity of the liquid is approximately 1.03 or less, for example, in a range of from 1.01 to 1.03. A specific gravity in a range may conveniently and inexpensively be obtained, for example, using sea water or diluted sea
15 water, as sea water has a specific gravity in a range of from 1.02 to 1.03, typically approximately 1.025.

In general, liquids with relatively low specific gravities (e.g., up to 1.25, up to 1.20) are relatively convenient to prepare and use, they may readily be obtained from solutions of common and inexpensive materials. For example, specific gravities of
20 aqueous sodium chloride solutions range from 1.00 to about 1.20, depending on concentration. Relatively low specific gravities are particularly suitable for efficiently removing inorganic materials, including for example, composite materials (e.g., fiberglass and polymers with glass filler) which have a lower specific gravity than pure inorganic materials, as well as relatively dense organic materials such as PVC, PET,
25 PTFE and thermoset polymers (e.g., as described herein).

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, specific gravities of at least 1.20, optionally at least 1.25, are obtained using high density water-soluble salts such as calcium salts, magnesium salts, transition metal salts, bromide salts and/or using suspensions.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, contact of waste material with a salt solution inhibits
30 microbial (e.g., bacterial) survival and/or activity in the obtained sorted material (in

addition to facilitating the sorting process). Such inhibition is comparable to preservation of food in salt water (e.g., pickling). Such inhibition may for example, enhance hygiene and/or reduce malodor of sorted material, thereby and facilitating handling and/or storage of the sorted material.

5 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, a concentration of salt in a solution is selected to be capable of inhibiting microbial (e.g., bacterial) survival and/or activity in waste material contacted with the solution, and/or in sorted material and/or processed material (e.g., as described herein) derived therefrom.

10 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the concentration of salt (e.g., sodium chloride, sea salt) in a salt solution (e.g., aqueous salt solution) is at least 3 weight percents. In some embodiments, the concentration of salt is in a range of from 3 to 35 weight percents. In some embodiments, the concentration of salt is in a range of from 3 to 30 weight
15 percents. In some embodiments, the concentration of salt is in a range of from 3 to 25 weight percents.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the concentration of salt (e.g., sodium chloride, sea salt) in a salt solution (e.g., aqueous salt solution) is at least 5 weight percents. In some
20 embodiments, the concentration of salt is in a range of from 5 to 35 weight percents. In some embodiments, the concentration of salt is in a range of from 5 to 30 weight percents. In some embodiments, the concentration of salt is in a range of from 5 to 25 weight percents.

In some of any of the embodiments pertaining to sorting waste material
25 according to specific gravity, the concentration of salt (e.g., sodium chloride, sea salt) in a salt solution (e.g., aqueous salt solution) is at least 10 weight percents. In some embodiments, the concentration of salt is in a range of from 10 to 35 weight percents. In some embodiments, the concentration of salt is in a range of from 10 to 30 weight percents. In some embodiments, the concentration of salt is in a range of from 10 to 25
30 weight percents.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the concentration of salt (e.g., sodium chloride, sea salt) in

a salt solution (e.g., aqueous salt solution) is at least 15 weight percents. In some embodiments, the concentration of salt is in a range of from 15 to 35 weight percents. In some embodiments, the concentration of salt is in a range of from 15 to 30 weight percents. In some embodiments, the concentration of salt is in a range of from 15 to 25 weight percents.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the concentration of salt (e.g., sodium chloride, sea salt) in a salt solution (e.g., aqueous salt solution) is at least 20 weight percents. In some embodiments, the concentration of salt is in a range of from 20 to 35 weight percents. In some embodiments, the concentration of salt is in a range of from 20 to 30 weight percents. In some embodiments, the concentration of salt is in a range of from 20 to 25 weight percents.

Without being bound by any particular theory, it is believed that contact of waste material with a salt solution comprising salt concentrations of at least 10 weight percents, especially at least 15 weight percents, and most especially at least 20 weight percents, is particularly effective at inhibiting microbial (e.g., bacterial) survival and/or activity not only in waste material contacted with the solution, but also at inhibiting microbial (e.g., bacterial) survival and/or activity in sorted material and/or processed material (e.g., as described herein) derived therefrom, that is, residual salt remaining in the sorted material and/or processed material (after the material has been removed from the salt solution) can effectively inhibit microbial survival and/or activity long after the separation according to specific gravity has been completed.

It is to be appreciated that cellulose and other compounds from animal material or plant material (e.g., lignin) are characterized by a specific gravity of approximately 1.5, but that animal materials and plant materials typically exhibit considerably lower specific gravities as a result of porosity (for, example, the voids in wood, which reduce the specific gravity of most wood to less than 1) and/or a considerable amount of water therein (which results in a specific gravity close to 1). Thus, a specific gravity of many materials is indicative of its water content and/or porosity.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, removal of materials with a relatively high specific gravity (e.g., as described herein) may increase a water content of the material (e.g., by

removing relatively dry animal material and/or plant material, while retaining relatively moist animal material and/or plant material), resulting in the obtained sorted material having a water content higher than that of the waste material (e.g., even without absorption of water during the separation process). Thus, removal of materials as described herein may be used to increase water content of the obtained sorted material (e.g., to a water content described herein), relative to the waste material, by facilitating absorption of water and/or by removing relatively dry materials.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, removal of materials with a relatively high specific gravity (e.g., as described herein) may result in the sorted material having a reduced (average) specific gravity, for example, less than 1.20, optionally less than 1.15, optionally less than 1.10, optionally less than 1.05, and optionally less than 1.00.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the sorted material contains at least 90 weight percents (dry weight) of an organic material, for example, by selecting a liquid in which inorganic materials sink.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the sorted material contains at least 90 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C (e.g., PET, PTFE), for example, by selecting a liquid in which such polymers sink.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the sorted material contains at least 90 weight percents (dry weight) of an organic material other than PVC, for example, by selecting a liquid in which PVC sinks.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the sorted material contains at least 90 weight percents (dry weight) of an organic material other than thermoset polymers, synthetic polymers having a melting point of at least 250 °C (e.g., PET, PTFE) and polyvinyl chloride (PVC), for example, by selecting a liquid in which such polymers sink.

In this respect, it is to be appreciated that thermoset polymers, synthetic polymers having a melting point of at least 250 °C (e.g., PET, PTFE) and polyvinyl chloride (PVC) are typically characterized by a relatively high specific gravity.

For example, among synthetic polymers characterized by a melting point of at least 250 °C, PET (which is particularly widespread in waste material, e.g., due to its use in food and liquid containers) typically exhibits a specific gravity in a range of from 1.37-1.455 and PTFE typically exhibits a specific gravity in a range of 2.1-2.2.

Similarly, polyvinyl chloride (a widespread polymer) typically exhibits a specific gravity in a range of from 1.35-1.45 in its rigid, relatively pure forms, whereas flexible forms of polyvinyl chloride typically exhibit a lower specific gravity (e.g., in a range of from 1.1-1.3) due to a presence of plasticizers. Thus, a liquid with a specific gravity below 1.1 may be suitable for removing substantially all polyvinyl chloride, whereas a liquid with a moderately higher specific gravity (e.g., in a range of from 1.1-1.3) may be suitable for removing a considerable proportion of polyvinyl chloride.

In addition, thermoset polymers typically comprise a considerable amount of heteroatoms (e.g., nitrogen, oxygen, sulfur), for example, in ester groups, urethane groups, and sulfur cross-links of vulcanized rubber, which increase the specific gravity of the polymer.

It is to be appreciated that contacting waste material with a liquid for separating according to specific gravity (according to any of the respective embodiments described herein) may effect partial removal of liquids which originate in the waste material and are miscible with the liquid for separating according to specific gravity, as the liquids remain intermixed when a sorted material is removed from the liquids. For example, aqueous liquids in a source waste material may optionally be at least partially removed upon contact with an aqueous liquid (e.g., salt solution) according to any of the respective embodiments described herein.

In addition, liquids (e.g., oils) are commonly present in the waste material which are immiscible with the liquid used for separating according to specific gravity (e.g., an aqueous solution), and form a distinct liquid layer during the separation process, for example, a layer of oils floating on a surface of an aqueous liquid (as opposed to floating solids which are partially submerged in the aqueous liquid).

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the method further comprises (as part of any one or more cycles of separating materials according to specific gravity) separating at least a portion of liquids of source waste material (which are immiscible with the liquid for separating according to specific gravity) from the other waste material and from the liquid for separating according to specific gravity. In some embodiments, oils in the source waste material which float on a surface of an aqueous liquid (e.g., salt solution) for separating according to specific gravity are separated.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the sorted material has a lower concentration of oils than does the waste material prior to sorting.

Herein, the term "oil" refers to a liquid which is immiscible with water, and encompasses substances which are liquid at a temperature in a range of 0 °C to 100 °C.

In some embodiments of any of the embodiments described herein, the oils are liquid at a temperature in a range of 0 °C to 50 °C. In some embodiments of any of the embodiments described herein, the oils are a liquid at 20 °C.

Herein, the phrase "immiscible with water" means that for at least some proportions of water and another liquid (e.g., an oil as defined herein), the liquid and the water do not form a homogeneous solution with one another, and separate into distinct phases.

In some embodiments of any of the embodiments described herein, the oil is composed of compounds characterized by a log P (logarithm of a partition coefficient) of at least 1. In some embodiments, the log P of compounds in the oil is at least 1.5. In some embodiments, the log P of compounds in the oil is at least 2.

Herein, the term "log P" refers to a logarithm of a ratio of a concentration of a compound in 1-octanol to a concentration of the compound in water, upon contact of the compound with a combination of 1-octanol and water (which form separate phases). The concentrations pertain to compounds in an unionized form.

Removal of immiscible liquids according to any of the respective embodiments described herein may optionally be performed using standard techniques known in the art. For example, a layer of oil may be skimmed from a surface of an aqueous solution using a weir skimmer, and/or an oleophobic and/or metallic skimmer (e.g., using a

rotating element such as a drum, rope, disc and/or belt to adhere to and remove oils). The skimmers (of any type) are optionally configured to cease skimming when oil is not present in sufficient quantities to be skimmed effectively.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, oils separated from the liquid for separating according to specific gravity (e.g., by skimming the oils from a surface of the liquid) are collected, for example, for use as a raw ingredient for further processing of oils.

Alternatively or additionally, separation of the oils may be in order to obtain a sorted material with less oil, and/or to reducing levels of oil impurities in the liquids used in a process described herein. In some such embodiments, the separated oils are discarded.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the oils comprise lipids released from cells in the waste material during the separation process, for example, upon contact with an aqueous salt solution (e.g., a hypertonic solution) which subjects the cells to osmotic stress.

Removal of materials may optionally be performed before and/or after shredding, and/or during shredding (e.g., between two stages of shredding).

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the waste material is a shredded waste material, that is, obtained in a shredded form, for example, waste material has been subjected to crushing (e.g., by a hammer mill). In some embodiments, the shredded waste material is further shredded as described herein.

As used herein, the terms “shred”, “shredded” and “shredding” and the further grammatical diversions thereof refer to reduction in size of the solid components of material (e.g., waste material, sorted material) by any mechanical means, including chopping, dicing, grinding, crumbling, cutting, tearing and crushing.

A variety of devices are available in the art for shredding waste material, including, without limitation, industrial shredders, grinders, chippers and granulators. Optionally, the device used for shredding is designed to be suitable for handling the presence of hard substances such as metal, glass, clay and stone in waste material, for example, by using blades or plates made of robust materials such as stainless steel or titanium.

Herein, the term “shredder” encompasses all devices configured for shredding, as defined herein.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, waste material is shredded prior to removal of materials
5 by contacting with a liquid (e.g., as described herein for, for example, sorting), for example, so as to facilitate separation of different types of material which are attached to one another (e.g., metal attached to plastic) and/or to facilitate escape of gases and entry of liquid to crevices in particles of waste material. In some embodiments, solid particles in the shredded material are less than 50 mm in diameter, optionally less than
10 20 mm in diameter, when materials are removed. In some embodiments, the solid particles are less than 10 mm in diameter when materials are removed.

In some embodiments, shredding prior to removal of materials is effected by hammers (e.g., crushing), for example, by a hammer mill.

Without being bound by any particular theory, it is believed that hammers are
15 relatively resistant to damage associated with a presence of hard materials (e.g., inorganic materials such as mineral, ceramic, glass, metal) in waste material which has not yet been subjected to removal of such materials.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, a sorted material is shredded subsequent to removal of
20 materials by contacting with a liquid (e.g., by shredding to a particle size described herein), for example, so as to remove hard and dense materials (e.g., inorganic materials) which may damage an apparatus effecting shredding, and/or so that particles of the waste material will not be so small as to interfere with removal of materials. For example, small particles generally separate according to specific gravity more slowly
25 than do large particles. In some embodiments, the solid particles are at least 2 mm in diameter when materials are removed. In some embodiments, the solid particles are at least 5 mm in diameter when materials are removed. In some embodiments, the solid particles are at least 10 mm in diameter when materials are removed.

In some embodiments of any of the embodiments described herein relating to
30 shredding, shredding subsequent to removal of materials is effected by cutting (e.g., by blades and/or plates), for example, in an industrial shredder.

Without being bound by any particular theory, it is believed that such a shredding technique is particularly suitable for forming relatively small particles, which may be more suitable for further processing (e.g., by mixing and heating as described herein), but may be relatively susceptible to hard and dense materials (e.g., inorganic materials), and therefore suitable for sorted material which has a reduced amount of such materials.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, waste material is shredded prior to removal of materials to a relatively large particle size (e.g., at least 10 mm in diameter), for example, using crushing, hammers and/or similar techniques. Subsequent to removal of materials, the sorted material is then optionally further shredded to smaller particles of a size (e.g., less than 10 mm in diameter) selected as suitable for further processing (e.g., mixing and heating as described herein).

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the method comprises more than one cycle of separating materials according to specific gravity.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the waste material is contacted with an aqueous liquid (e.g., as described herein) to thereby obtain a partially sorted material, and the partially sorted waste material is further subjected to at least one additional cycle of separating materials according to specific gravity. In each of the aforementioned at least one additional cycle, the separating comprises contacting the partially sorted waste material with an additional liquid (e.g., a liquid described herein for separating materials).

Herein, the phrase “partially sorted material” refers to a sorted material, as defined herein, which is intended to be subjected to further sorting. Thus, the phrase “sorted material” encompasses “partially sorted material”.

It is to be understood that each cycle may be effected with a liquid (e.g., an aqueous salt solution) which is the same or different than a liquid (e.g., an aqueous salt solution) used in another cycle, and that each cycle may independently comprise removing the high-density materials (e.g., materials which sink in the liquid) from the waste material or removing the low-density materials (e.g., materials which float in the liquid) from the waste material.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, at least one cycle of separating materials according to specific gravity comprises removing material which sinks in the liquid of that cycle. In some embodiments, at least one cycle other than the first cycle (i.e., at least one
5 additional cycle) comprises removing material which sinks in the liquid of that cycle (i.e., an additional liquid described herein). In some embodiments, a first cycle comprises removing material which sinks in the liquid of that cycle. In some embodiments, a first cycle and at least one additional cycle comprises removing material which sinks in the liquid of that cycle.

10 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, at least one cycle of separating materials according to specific gravity comprises removing material which floats in the liquid of that cycle. In some embodiments, a first cycle comprises removing material which sinks in the liquid of that cycle, and at least one later cycle comprises removing material which floats in
15 the liquid of that cycle.

Each cycle may be independently optionally further comprise shredding the obtained sorted material (optionally partially sorted material after cycles other than the final cycle) subsequent to contact with the liquid of that cycle (e.g., as described herein). In some embodiments of any of the embodiments pertaining to sorting waste
20 material, at least one cycle other than the first cycle (i.e., at least one additional cycle) further comprises shredding of the sorted material subsequent to contact with the liquid of that cycle (i.e., an additional liquid described herein). In some embodiments, the final cycle comprises shredding of the sorted material (i.e., after contact with the liquid of the final cycle). In some embodiments, each cycle comprises shredding of the
25 obtained sorted material (including partially sorted material after cycles other than the final cycle).

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, removal of liquid is performed subsequent to at least one cycle of separating materials according to specific gravity. The removal of liquid may
30 optionally be effected by drainage (e.g., gravity-driven drainage) and/or compression of the sorted material, for example, using a screw press. Optionally, at least a portion of the removed liquid is reused for separating materials as described herein.

In some of any of the embodiments pertaining to sorting waste material according to specific gravity, removed liquid comprises liquid which originates in the waste material, for example, aqueous liquids and/or oils. For example, liquid removed according to any of the respective embodiments described herein (e.g., by drainage
5 and/or compression) may optionally comprise an aqueous liquid (e.g., salt solution) used for separating according to specific gravity (according to any of the respective embodiments described herein), as well as aqueous liquid originating in the waste material which is intermixed with the aqueous liquid for separating according to specific gravity, and/or oils originating in the waste material.

10 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, separation of oils from the removed liquid is performed, for example, in order to collect oils for further processing, and/or to facilitate reuse of a liquid (e.g., aqueous liquid) for separating materials by reducing levels of oil impurities.

Separation of oils from the removed liquid may be performed according to
15 techniques and apparatuses known in the art, for example, electrochemical emulsification; bioremediation; oil-water separators known in the art, including, without limitation, gravity oil-water separators (e.g., API separators, gravity plate separators) and centrifugal oil-water separators; and/or a skimmer (e.g., any skimmer described herein).

20 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, the method comprises both collecting oils separated from the liquid for separating according to specific gravity (e.g., by skimming the oils from a surface of the liquid) according to any of the respective embodiments described herein, as well as collecting oils separated from removed liquid according to any of the
25 respective embodiments described herein, and combining the collected oils, for example, for further processing. That is, in such embodiments, oil is collected both during at least one cycle of separating materials (wherein waste material is contacted with a liquid), and subsequent to at least one cycle of separating materials (wherein liquid is removed from sorted material, and oils are separated from the removed liquid).

30 In some of any of the embodiments pertaining to sorting waste material according to specific gravity, separated materials (e.g., inorganic materials) are further sorted (e.g., using techniques known in the art) so as to extract useful and/or valuable

materials such as metals (e.g., iron, gold) and silica and/or glass (e.g., for use as filler in concrete, plastics, and the like).

It is to be noted that the removal of materials as described herein affects the chemical composition of the end product (e.g., a processed material obtained by
5 processing the sorted material as described herein) and that the selection of the liquid used in any of these embodiments can be made also in accordance with the desired characteristics of the end product, so as to retain in the waste material materials of a chemical composition that would impart the desired characteristics of the end product.

For example, the dry weight of a representative domestic waste material may
10 comprise about 60 % of wood-derived materials (e.g., paper, cardboard, branches) containing lignin, typically in the form of lignocellulose; about 20 % of organic materials without lignin (e.g., plastics, non-woody plant-derived material such as food); and about 20 % of inorganic materials (e.g., stone, sand, glass, ceramic, metal). The proportion of lignocellulose-containing materials (e.g., materials containing lignin,
15 cellulose and/or hemicellulose) is expected to increase upon removal of dense materials such as inorganic materials and/or polymers such as thermoset polymers, PET and PVC from the waste material, as described herein.

The sorted material obtained as described herein is particularly amenable to further processing according to procedures uncovered by the present inventor and
20 described herein. Furthermore, such procedures are particularly suitable for processing wet material, such as waste material sorted by contact with a liquid (e.g., as described herein). Thus, the sorting and further processing may be combined as a particularly efficient and effective method of processing waste material.

In some of any of the embodiments pertaining to separating materials according
25 to specific gravity as described herein, removal of inorganic materials in the waste material is such that an obtained sorted material contains at least 90 weight percents (dry weight) of an organic material. In some embodiments, the sorted material contains at least 95 weight percents (dry weight) of an organic material. In some embodiments, the sorted material contains at least 98 weight percents (dry weight) of an organic
30 material. In some embodiments, the sorted material contains at least 99 weight percents (dry weight) of an organic material.

In some of any of the embodiments pertaining to separating materials according to specific gravity as described herein, the method comprises removing at least a portion of certain organic materials (e.g., synthetic polymers, as defined herein) in the waste. In some embodiments, the method comprises removing at least a portion of polyvinyl chloride, synthetic polymers having a relatively high melting point (e.g., at least 250 °C) and/or thermoset polymers (e.g., as described herein).

In some of any of the embodiments pertaining to separating materials according to specific gravity as described herein, the sorted material contains at least 90 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the sorted material contains at least 95 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the sorted material contains at least 98 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the sorted material contains at least 99 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C.

In some of any of the embodiments pertaining to separating materials according to specific gravity as described herein, the sorted material contains at least 90 weight percents (dry weight) of an organic material other than PVC. In some embodiments, the sorted material contains at least 95 weight percents (dry weight) of an organic material other than PVC. In some embodiments, the sorted material contains at least 98 weight percents (dry weight) of an organic material other than PVC. In some embodiments, the sorted material contains at least 99 weight percents (dry weight) of an organic material other than PVC.

In some of any of the embodiments pertaining to separating materials according to specific gravity as described herein, the sorted material contains at least 90 weight percents (dry weight) of an organic material other than PVC, thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the sorted material contains at least 95 weight percents (dry weight) of an organic material other than PVC, thermoset polymers and synthetic polymers having a melting point of

at least 250 °C. In some embodiments, the sorted material contains at least 98 weight percents (dry weight) of an organic material other than PVC, thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the sorted material contains at least 99 weight percents (dry weight) of an organic material
5 other than PVC, thermoset polymers and synthetic polymers having a melting point of at least 250 °C.

In some of any of the embodiments pertaining to separating materials according to specific gravity as described herein, no more than 5 weight percents of the dry weight of the sorted material is inorganic material. In some embodiments, no more than 4
10 weight percents is inorganic material. In some embodiments, no more than 3 weight percents is inorganic material. In some embodiments, no more than 2 weight percents is inorganic material. In some embodiments, no more than 1 weight percent is inorganic material. In some embodiments, no more than 0.5 weight percent is inorganic material. In some embodiments, no more than 0.2 weight percent is inorganic material. In some
15 embodiments, no more than 0.1 weight percent is inorganic material.

Herein, wherever an amount of "inorganic material" in a sorted material and/or feedstock is described, the amount does not include any inorganic water-soluble salt and/or ions included in an aqueous liquid used for separation as described herein.

Without being bound by any particular theory, it is believed that such salts do
20 not have a substantial deleterious effect, and may even have a beneficial effect, on further processing of the sorted material, whereas other inorganic materials are likely to have a deleterious effect (e.g., as described herein), and hence, it is advantageous to reduce an amount of such inorganic material.

As described in detail herein, the sorted material obtained as described herein is
25 particularly amenable to further processing. The sorted material may optionally be subjected to further processing as is, or may be used to prepare a feedstock intended for processing.

Without being bound by any particular theory, it is believed that the sorted material obtained as described herein is particularly amenable to processing comprising
30 moderate heating, mixing and/or extrusion, as materials which are less amenable to such processing, such as materials which do not melt or substantially soften at such temperatures (e.g., inorganic materials, thermoset polymers, polymers having a

relatively high melting point), materials which form toxic products upon heating at such temperatures (e.g., polyvinylchloride), highly abrasive materials (e.g., hard inorganic materials) and materials which tend to cause clogging (including, but not limited to, materials which do not melt or substantially soften upon heating at such temperatures).

5 Furthermore, procedures described herein are particularly suitable for processing wet material, such as waste material sorted by contact with a liquid (e.g., as described herein).

 Furthermore, the sorted material obtained as described herein facilitates recycling of waste material by removing materials which are not amenable to recycling, such as toxic metals and minerals (e.g., arsenic, cadmium, cobalt, chromium, mercury, 10 nickel, lead, antimony, selenium, asbestos), and materials which are typically not recycled due to formation of toxic products upon heating (e.g., polyvinylchloride).

 Thus, the sorting and further processing may be combined as a particularly efficient and effective method of processing waste material.

15 Hence, according to an aspect of some embodiments of the present invention, there is provided a method of processing waste material so as to form a non-particulate processed material. The method comprises providing a feedstock comprising a sorted material derived from a waste material (e.g., as described herein). In some 20 embodiments of the embodiments pertaining to a method of processing waste material as described herein, the method is effected by subjecting the feedstock to mixing via shear forces, and subjecting the feedstock to heating, to thereby obtain a processed material. The feedstock is preferably subjected to the mixing and the heating without being dried beforehand.

 Thus, in some embodiments of any of the embodiments described herein, the 25 method of processing waste material as described herein incorporates a method of sorting waste material according to any one of the embodiments described herein pertaining to separating materials according to specific gravity as described herein.

 Herein, the term “feedstock” refers to a material subjected to processing (material that is processed) by heating and/or mixing as described herein, except where 30 indicated otherwise. The feedstock may consist of a sorted material as described herein, in any one of the respective embodiments, or may be different than the sorted material,

for example, when a feedstock comprises a sorted material in combination with one or more additional materials (e.g., as described herein).

In some embodiments of the embodiments pertaining to a method of processing waste material as described herein, the term “feedstock” encompasses a sorted material as described herein. In some embodiments, the term “feedstock” describes a sorted material as described herein combined (e.g., mixed) with one or more additional materials, as described herein.

Herein, the term “non-particulate” refers to a solid material which is not composed of discrete particles (e.g., particles adhered to one another, or optionally aggregates thereof) having a volume of more than 0.2 mm^3 , that is, the material is not formed of particles of the aforementioned volume characterized by visible boundaries and/or particles consisting of different substances than their adjacent surroundings. In some embodiments of the embodiments pertaining to a method of processing waste material as described herein, the non-particulate material is not composed of discrete particles having a volume of more than 0.04 mm^3 . In some embodiments, the non-particulate material is not composed of discrete particles having a volume of more than 0.01 mm^3 . It is to be understood that a non-particulate material may comprise some discrete particles embedded therein, but that the bulk of the material comprises a continuous non-particulate matrix.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, less than 20 weight percents of the non-particulate processed material consists of discrete particles. In some embodiments, less than 10 weight percents of the non-particulate processed material consists of discrete particles. In some embodiments, less than 5 weight percents of the non-particulate processed material consists of discrete particles. In some embodiments, less than 2 weight percents of the non-particulate processed material consists of discrete particles. In some embodiments, less than 1 weight percents of the non-particulate processed material consists of discrete particles.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, heating is performed subsequent to mixing. In some embodiments, heating is performed prior to mixing. In some embodiments, the feedstock is subjected to mixing and heating simultaneously.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 50 weight percents of the dry weight of the feedstock is a sorted material obtained by separating materials in a waste material according to specific gravity, as described herein. In some embodiments, at least 60 weight percents of the dry weight of the feedstock is a sorted material. In some embodiments, at least 70 weight percents of the dry weight of the feedstock is a sorted material. In some embodiments, at least 80 weight percents of the dry weight of the feedstock is a sorted material. In some embodiments, at least 90 weight percents of the dry weight of the feedstock is a sorted material. In some embodiments, at least 95 weight percents of the dry weight of the feedstock is a sorted material. In some embodiments, at least 98 weight percents of the dry weight of the feedstock is a sorted material. In some embodiments, at least 99 weight percents of the dry weight of the feedstock is a sorted material. In some embodiments, substantially all of the dry weight of the feedstock is a sorted material.

Herein, descriptions of a feedstock and/or a composition thereof, refer to a feedstock prior to mixing and heating, except where indicated otherwise.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, the feedstock (prior to mixing and heating) has a water content of at least 15 weight percents. In some embodiments, the feedstock has a water content of at least 20 weight percents. In some embodiments, the feedstock has a water content of at least 30 weight percents. In some embodiments, the feedstock has a water content of at least 40 weight percents. In some embodiments, the feedstock has a water content of at least 45 weight percents. In some embodiments, the feedstock has a water content of at least 50 weight percents. In some embodiments, the feedstock has a water content of at least 55 weight percents. In some embodiments, the feedstock has a water content of at least 60 weight percents.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, the feedstock (prior to mixing and heating) has a water content of from 15 to 70 weight percents. In some embodiments, the feedstock has a water content of from 20 to 70 weight percents. In some embodiments, the feedstock has a water content of from 30 to 70 weight percents. In some embodiments, the feedstock has a water content of from 40 to 70 weight percents. In some embodiments, the

feedstock has a water content of from 45 to 70 weight percents. In some embodiments, the feedstock has a water content of from 50 to 70 weight percents. In some embodiments, the feedstock has a water content of from 55 to 70 weight percents. In some embodiments, the feedstock has a water content of from 60 to 70 weight percents.

5 In some embodiments, the feedstock has a water content of about 64 weight percents.

The origin of water in the feedstock may optionally be the water content of a waste material, an aqueous liquid used for separation according to specific gravity (e.g., as described herein), and/or water added to a sorted material.

In some embodiments of any of the embodiments pertaining to processing waste material described herein, the feedstock has a water content which is higher than that of a waste material from which it is derived. For example, the contact of waste material with an aqueous liquid during separation according to specific gravity as described may result in a sorted material (which is then comprised by the feedstock) having a water content which is higher than that of a waste material from which it is derived (e.g., due to absorption of the aqueous liquid). Additionally or alternatively, water is added to the sorted material to produce the feedstock. Thus, the feedstock may optionally have a water content which is higher than that of the sorted material.

It is to be appreciated that the use of an aqueous liquid to separate materials is particularly suitable in the context of a method suitable for utilizing a feedstock having a relatively high water content (e.g., as described herein), as the incorporation of water from the aqueous liquid into the sorted material is not necessarily a problem when using such a feedstock.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 20 weight percents of the dry weight of the feedstock is lignocellulose. In some embodiments, from 20 to 95 weight percents of the dry weight is lignocellulose. In some embodiments, from 20 to 90 weight percents of the dry weight is lignocellulose. In some embodiments, from 20 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, from 20 to 80 weight percents of the dry weight is lignocellulose. In some embodiments, from 20 to 70 weight percents of the dry weight is lignocellulose. In some embodiments, from 20 to 60 weight percents of the dry weight is lignocellulose. In some embodiments, from 20 to 50 weight percents of the dry weight is lignocellulose. In some embodiments, at least

40 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 60 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 80 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 90 weight percents of the lignocelluloses is carbohydrates.

5 As used herein, the term "lignocellulose" refers to dry matter derived from plants, which is composed primarily of carbohydrates (primarily cellulose and hemicelluloses) and lignin. Thus, an amount of lignocellulose described herein may be considered a total amount of dry matter derived from plants, regardless of the proportions of, e.g., carbohydrates and lignin.

10 Without being bound by any particular theory, it is believed that the carbohydrates in lignocelluloses (e.g., cellulose and/or hemicelluloses) are particularly amenable to processing as described herein (e.g., as compared to lignin) and provide desirable properties to the obtained process material. The proportion of carbohydrates in the lignocellulose may optionally be enhanced by limiting an amount of lignin-rich
15 material in the waste material being processed, for example, by using waste material with no more than a limited amount of wood (e.g., tree trimmings, lumberyard waste).

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 30 weight percents of the dry weight of the feedstock is lignocellulose. In some embodiments, from 30 to 95 weight percents of the
20 dry weight is lignocellulose. In some embodiments, from 30 to 90 weight percents of the dry weight is lignocellulose. In some embodiments, from 30 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, from 30 to 80 weight percents of the dry weight is lignocellulose. In some embodiments, from 30 to 70 weight percents of the dry weight is lignocellulose. In some embodiments, from 30 to
25 60 weight percents of the dry weight is lignocellulose. In some embodiments, from 30 to 50 weight percents of the dry weight is lignocellulose. In some embodiments, at least 40 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 60 weight percents of the lignocelluloses is carbohydrates. In some
30 embodiments, at least 80 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 90 weight percents of the lignocelluloses is carbohydrates.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 40 weight percents of the dry weight of the

feedstock is lignocellulose. In some embodiments, from 40 to 95 weight percents of the dry weight is lignocellulose. In some embodiments, from 40 to 90 weight percents of the dry weight is lignocellulose. In some embodiments, from 40 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, from 40 to 80 weight percents of the dry weight is lignocellulose. In some embodiments, from 40 to 70 weight percents of the dry weight is lignocellulose. In some embodiments, from 40 to 60 weight percents of the dry weight is lignocellulose. In some embodiments, at least 40 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 60 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 80 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 90 weight percents of the lignocelluloses is carbohydrates.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 50 weight percents of the dry weight of the feedstock is lignocellulose. In some embodiments, from 50 to 95 weight percents of the dry weight is lignocellulose. In some embodiments, from 50 to 90 weight percents of the dry weight is lignocellulose. In some embodiments, from 50 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, from 50 to 80 weight percents of the dry weight is lignocellulose. In some embodiments, from 50 to 75 weight percents of the dry weight is lignocellulose. In some embodiments, from 50 to 70 weight percents of the dry weight is lignocellulose. In some embodiments, at least 40 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 60 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 80 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 90 weight percents of the lignocelluloses is carbohydrates.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 60 weight percents of the dry weight of the feedstock is lignocellulose. In some embodiments, from 60 to 95 weight percents of the dry weight is lignocellulose. In some embodiments, from 60 to 90 weight percents of the dry weight is lignocellulose. In some embodiments, from 60 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, from 60 to 80 weight percents of the dry weight is lignocellulose. In some embodiments, at least 40 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 60

weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 80 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 90 weight percents of the lignocelluloses is carbohydrates.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 70 weight percents of the dry weight of the feedstock is lignocellulose. In some embodiments, from 70 to 95 weight percents of the dry weight is lignocellulose. In some embodiments, from 70 to 90 weight percents of the dry weight is lignocellulose. In some embodiments, from 70 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, from 75 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, from 80 to 85 weight percents of the dry weight is lignocellulose. In some embodiments, at least 40 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 60 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 80 weight percents of the lignocelluloses is carbohydrates. In some embodiments, at least 90 weight percents of the lignocelluloses is carbohydrates.

Typically, the feedstock will comprise at least a portion of the synthetic polymers in the waste material, which are present in the sorted material. In addition, the feedstock may optionally comprise synthetic polymers added to the sorted material (e.g., an additional material described herein).

Herein, the phrase "synthetic polymers" refers to polymers other than those found in plant or animal material (e.g., lignin, carbohydrates, polypeptides) or polymers formed from heating and mixing plant or animal material as described herein (e.g., products of hydrolysis, caramelization and/or pyrolysis of carbohydrates, polypeptides, etc.). Examples of synthetic polymers include, without limitation, polyolefins, polystyrene, polyvinylchloride, polyethylene terephthalate, polyacrylonitrile, polybutadiene, polystyrene, polycarbonate, polyesters (e.g., rayon), and nylon. Polymers formed by chemical reactions of a natural polymer, for example, cellulose which has been chemically treated (e.g., by carbon disulfide) and regenerated to form rayon, are considered herein to be synthetic polymers. The skilled person will be aware of additional synthetic polymers which may be found in waste material, and which consequently may be included in the feedstock described herein.

Without being bound by any particular theory, it is believed that polyolefins will comprise a substantial portion of the synthetic polymers in the sorted material and feedstock, due to the relatively low specific gravity of polyolefins. In addition, the feedstock may optionally further comprise synthetic polymers added to the sorted material.

Herein, the term "polyolefin" refers to a polymer prepared from an olefin monomer. Examples of polyolefins include, without limitation, polyethylene, polypropylene, polymethylpentene, polybutene-1, polyisobutylene, ethylene propylene rubber, ethylene propylene diene monomer rubber, and copolymers thereof. Polyethylene and polypropylene are particularly common in waste material, and therefore likely to be present in substantial amounts in the sorted material and feedstock.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 50 weight percents of the synthetic polymers is polyolefins. In some embodiments, at least 60 weight percents of the synthetic polymers is polyolefins. In some embodiments, at least 70 weight percents of the synthetic polymers is polyolefins. In some embodiments, at least 80 weight percents of the synthetic polymers is polyolefins. In some embodiments, at least 90 weight percents of the synthetic polymers is polyolefins.

Without being bound by any particular theory, it is believed that thermoplastic polymers will comprise a substantial portion of the synthetic polymers in the sorted material and feedstock, due to the relatively low specific gravity of many thermoplastic polymers, including, but not limited to thermoplastic polyolefins (e.g., polyethylene, polypropylene, polymethylpentene, polybutene-1). In addition, the feedstock may optionally further comprise thermoplastic polymers added to the sorted material. It is further believed that thermoplastic polymers, particularly thermoplastic synthetic polymers, undergo softening and/or melting upon mixing and heating as described herein, which allows for a more homogeneous processed material.

Furthermore, the presence of one or more thermoplastic synthetic polymers may optionally enhance the thermoplasticity of the processed material (e.g., a polymeric material described herein), and/or allow for recycling of the synthetic polymer.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 50 weight percents of the synthetic polymers is thermoplastic. In some embodiments, at least 60 weight percents of the synthetic polymers is thermoplastic. In some embodiments, at least 70 weight percents of the synthetic polymers is thermoplastic. In some embodiments, at least 80 weight percents of the synthetic polymers is thermoplastic. In some embodiments, at least 90 weight percents of the synthetic polymers is thermoplastic. In some embodiments, at least 95 weight percents of the synthetic polymers is thermoplastic.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 5 weight percents of the dry weight of the feedstock comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 80 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 70 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 60 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 50 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 40 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 30 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 25 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 20 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 5 to 15 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, at least 50 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 60 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 70 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 80 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 90 weight percents of the synthetic polymers comprises or is consisted of polyolefins.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 10 weight percents of the dry weight of the feedstock comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 80 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 70 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 60 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 50 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 40 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 30 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 25 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 20 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 10 to 15 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, at least 50 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 60 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 70 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 80 weight percents of the synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at least 90 weight percents of the synthetic polymers is polyolefins.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 15 weight percents of the dry weight of the feedstock is synthetic polymers. In some embodiments, from 15 to 80 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 15 to 70 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 15 to 60 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 15 to 50 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 15 to 40 weight percents of the dry weight comprises or is consisted of synthetic polymers. In some embodiments, from 15 to 30 weight percents

of the dry weight comprises or is consisted of synthetic polymers. In some
embodiments, from 15 to 25 weight percents of the dry weight comprises or is consisted
of synthetic polymers. In some embodiments, from 15 to 20 weight percents of the dry
weight comprises or is consisted of synthetic polymers. In some embodiments, at least
5 50 weight percents of the synthetic polymers comprises or is consisted of polyolefins.
In some embodiments, at least 60 weight percents of the synthetic polymers comprises
or is consisted of polyolefins. In some embodiments, at least 70 weight percents of the
synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at
least 80 weight percents of the synthetic polymers comprises or is consisted of
10 polyolefins. In some embodiments, at least 90 weight percents of the synthetic
polymers is polyolefins.

In some of any of the embodiments pertaining to a method of processing waste
material as described herein, at least 20 weight percents of the dry weight of the
feedstock is synthetic polymers. In some embodiments, from 20 to 80 weight percents
15 of the dry weight comprises or is consisted of synthetic polymers. In some
embodiments, from 20 to 70 weight percents of the dry weight comprises or is consisted
of synthetic polymers. In some embodiments, from 20 to 60 weight percents of the dry
weight comprises or is consisted of synthetic polymers. In some embodiments, from 20
to 50 weight percents of the dry weight comprises or is consisted of synthetic polymers.
20 In some embodiments, from 20 to 40 weight percents of the dry weight comprises or is
consisted of synthetic polymers. In some embodiments, from 20 to 30 weight percents
of the dry weight comprises or is consisted of synthetic polymers. In some
embodiments, from 20 to 25 weight percents of the dry weight comprises or is consisted
of synthetic polymers. In some embodiments, at least 50 weight percents of the
25 synthetic polymers comprises or is consisted of polyolefins. In some embodiments, at
least 60 weight percents of the synthetic polymers comprises or consists of polyolefins.
In some embodiments, at least 70 weight percents of the synthetic polymers comprises
or is consisted of polyolefins. In some embodiments, at least 80 weight percents of the
synthetic polymers comprises or consists of polyolefins. In some embodiments, at least
30 90 weight percents of the synthetic polymers is polyolefins.

In some of any of the embodiments pertaining to a method of processing waste
material as described herein, at least 25 weight percents of the dry weight of the

feedstock is synthetic polymers. In some embodiments, from 25 to 80 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 25 to 70 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 25 to 60 weight percents of the dry weight
5 comprise or consist of synthetic polymers. In some embodiments, from 25 to 50 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 25 to 40 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 25 to 30 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, at least 50
10 weight percents of the synthetic polymers is polyolefins. In some embodiments, at least 60 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 70 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 80 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least
15 90 weight percents of the synthetic polymers is polyolefins.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 30 weight percents of the dry weight of the feedstock comprise or consist of synthetic polymers. In some embodiments, from 30 to 80 weight percents of the dry weight comprise or consist of synthetic polymers. In
20 some embodiments, from 30 to 70 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 30 to 60 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 30 to 50 weight percents of the dry weight comprise or consist of synthetic polymers. In some
25 embodiments, from 30 to 40 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, at least 50 weight percents of the synthetic polymers is polyolefins. In some embodiments, at least 60 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least
30 70 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 80 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 90 weight percents of the synthetic polymers is polyolefins.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 40 weight percents of the dry weight of the feedstock is synthetic polymers. In some embodiments, from 40 to 80 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 40 to 70 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 40 to 60 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 40 to 50 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, at least 50 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 60 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 70 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 80 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 90 weight percents of the synthetic polymers is polyolefins.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 50 weight percents of the dry weight of the feedstock comprise or consist of synthetic polymers. In some embodiments, from 50 to 80 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 50 to 70 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, from 50 to 60 weight percents of the dry weight comprise or consist of synthetic polymers. In some embodiments, at least 50 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 60 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 70 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 80 weight percents of the synthetic polymers comprise or consist of polyolefins. In some embodiments, at least 90 weight percents of the synthetic polymers is polyolefins.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, the feedstock contains at least 90 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the feedstock contains

at least 95 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the feedstock contains at least 98 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the feedstock contains at least 99 weight percents (dry weight) of an organic material other than thermoset polymers and synthetic polymers having a melting point of at least 250 °C.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, the feedstock contains at least 90 weight percents (dry weight) of an organic material other than PVC. In some embodiments, the feedstock contains at least 95 weight percents (dry weight) of an organic material other than PVC. In some embodiments, the feedstock contains at least 98 weight percents (dry weight) of an organic material other than PVC. In some embodiments, the feedstock contains at least 99 weight percents (dry weight) of an organic material other than PVC.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, the feedstock contains at least 90 weight percents (dry weight) of an organic material other than PVC, thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, feedstock contains at least 95 weight percents (dry weight) of an organic material other than PVC, thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the feedstock contains at least 98 weight percents (dry weight) of an organic material other than PVC, thermoset polymers and synthetic polymers having a melting point of at least 250 °C. In some embodiments, the feedstock contains at least 99 weight percents (dry weight) of an organic material other than PVC, thermoset polymers and synthetic polymers having a melting point of at least 250 °C.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, no more than 5 weight percents of the dry weight of the feedstock is inorganic material. In some embodiments, no more than 4 weight percents is inorganic material. In some embodiments, no more than 3 weight percents is inorganic material. In some embodiments, no more than 2 weight percents is inorganic material. In some embodiments, no more than 1 weight percent is inorganic material. In some embodiments, no more than 0.5 weight percent is inorganic material. In some

embodiments, no more than 0.2 weight percent is inorganic material. In some embodiments, no more than 0.1 weight percent is inorganic material.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, at least 1 weight percent of the dry weight of the feedstock is inorganic salts (e.g., including inorganic salts derived from an aqueous salt solution used for separation according to specific gravity). In some embodiments, at least 1.5 weight percent of the dry weight of the feedstock is inorganic salts. In some embodiments, at least 2 weight percent of the dry weight of the feedstock is inorganic salts. In some embodiments, at least 2.5 weight percent of the dry weight of the feedstock is inorganic salts. In some embodiments, at least 3 weight percent of the dry weight of the feedstock is inorganic salts.

Without being bound by any particular theory, it is believed that inorganic salts (e.g., salts derived from an aqueous salt solution used for separation according to specific gravity) facilitate processing of the feedstock by mixing and heating (e.g., as described herein) to form a processed material with desirable properties.

In some of any of the embodiments described herein in the context of a method of processing waste material, the feedstock comprising a sorted material as described herein may optionally consist essentially of the sorted material.

Alternatively, in some of any of the embodiments described herein in the context of a method of processing waste material, providing the feedstock as described herein comprises combining the sorted material with one or more additional materials. In some embodiments, the method further comprises mixing the sorted material with an additional material. An additional material may optionally be added to the sorted material in order to fine-tune the composition of the feedstock (e.g., to arrive at a feedstock composition described herein) and/or to impart the obtained processed material with a desired property and/or because it is desired to process the additional material (e.g., so as to avoid the need to dispose of it by other means).

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the sorted material and the additional material are mixed (e.g., the feedstock is provided) prior to subjecting the feedstock to mixing via shear forces as described herein. Thus, the heating and mixing via shear forces described herein is optionally performed on a previously prepared feedstock.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the sorted material and the additional material are mixed concomitantly with subjecting the material to mixing via shear forces as described herein, that is, providing the feedstock and subjecting the feedstock to mixing via shear forces are optionally performed concomitantly.

In some of any of the embodiments described herein in the context of a method of processing waste material, the method further comprises mixing the processed material with an additional material. In these embodiments, the additional material can be mixed with a processed material obtained at the end of processing of the feedstock (e.g., upon subjecting the feedstock to one or numerous cycles of heating and/or mixing), or, during processing of the feedstock (e.g., upon subjecting the feedstock to a first cycle of heating and/or mixing and prior to subjecting the feedstock to a second cycle of heating and/or mixing; upon subjecting the feedstock to a first cycle of heating and/or mixing and prior to gas removal; upon subjecting the feedstock to a first cycle of heating and/or mixing, subsequent to gas removal and prior to subjecting the feedstock to a second cycle of heating and/or mixing; or upon subjecting the feedstock to a first cycle of heating and/or mixing and gas removal and to a second cycle of heating and/or mixing, but prior to a second gas removal).

In embodiments where an additional material is mixed with a processed material, the additional material is supplemented to the container where processing is performed, at a desired section of the container.

In any of the embodiments described herein relating to an additional material, an additional material added to a sorted material may optionally be a material consisting primarily (e.g., more than 50 weight percents) of water, for example, water or an aqueous solution. As described herein, addition of water may be used to increase a water content of the feedstock.

In any of the embodiments described herein relating to an additional material, the additional material (other than water) may optionally comprise animal and/or plant material.

Alternatively or additionally, the additional material (other than water) is not derived from plants or animals.

Examples of animal material which may be added (e.g., to the sorted material) include, without limitation, fecal material (e.g., sewage solids, manure), corpses, animal organs, feathers, hair (e.g., wool), meat, animal fat, dairy products, egg shells, and bones.

5 Examples of plant material which may be added (e.g., to the sorted material), without limitation, hay, grass clippings, cuttings, trimmings, inedible portions of crops, leaves, sawdust, wood chips, leaves bark, fruit, vegetables, grains, vegetable oil, textiles (e.g., cotton, linen, hemp, jute) and paper products (e.g., paper, cardboard).

10 Animal material and/or plant material may optionally be added (e.g., to the sorted material), for example, in order to dispose of waste, such as sewage (e.g., in the form of sewage sludge), agricultural waste (e.g., sorted agricultural waste), food industry waste, gardening byproducts and/or carpentry byproducts, and/or for recycling paper products (e.g., as part of a municipal recycling program).

15 Alternative examples of optional additional materials (i.e., other than animal or plant material) include, without limitation, minerals (e.g., sand, dried cement, stone), glasses (including fiberglass), metals, and polymeric materials (e.g., synthetic polymers in textiles and/or rubbers). Such materials may optionally be added, for example, in order to recycle industrial waste, waste from construction activities and the like, and/or in order to modify and/or enhance the physical properties of the processed material (e.g., similarly to the inclusion of sand in concrete). For example, an additional material
20 may be an elastic material (e.g., rubber or another elastomer), a fiber (e.g., a glass fiber, a polymeric fiber) for enhancing mechanical strength, and/or a polymer for modifying the properties of the obtained processed material by blending with the processed material (e.g., in a form of a polymer blend).

25 In embodiments, wherein an additional material is substantially an inorganic material (e.g., a minerals, glass and/or metal), the additional material is preferably added to the obtained process material (e.g., so as to avoid interference of the inorganic material with the processing described herein) and/or selected so as to be a form which does not interfere excessively with the processing (e.g., a fine grained form which does
30 not cause excessive abrasion and/or clogging).

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, an additional material and/or an amount

thereof is selected based on a composition of the sorted material and a desired composition of the feedstock (e.g., a feedstock composition described herein), for example, wherein a composition of sorted material differs from a desired composition of the feedstock.

5 In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, a waste material to be processed (and/or an amount thereof) and an additional material (and/or an amount thereof) are selected so as to be complementary, for example, wherein an expected composition of a sorted material derived from the waste material is expected to differ from a desired
10 composition of the feedstock.

For example, in some embodiments, the waste material comprises a relatively high percentage of plant and/or animal material (e.g., in a form of agricultural waste, trimmings, cuttings, leaves, cardboard, sewage sludge and the like), and consequently has less synthetic polymer (e.g., polyolefins) than desired in the feedstock (e.g., in
15 accordance with a feedstock composition described herein), and the additional material is selected to comprise a synthetic material, to thereby obtain the desired feedstock composition (e.g., while also facilitating recycling of the aforementioned waste material).

In some embodiments of any of the embodiments described herein in the context
20 of a method of processing waste material, the additional material comprises material (e.g., an inorganic material, a polymer) separated from a material (e.g., primarily inorganic material) previously separated from the waste material as described herein, that is, a portion of the material (e.g., an inorganic material, a polymer) removed from the waste material is returned thereto.

25 The additional material may optionally be a sorted material obtained by sorting the same waste material (e.g., using a different process) and/or a sorted material obtained by sorting a different waste material.

For example, an additional material may optionally comprise at least a portion of a lignocellulose-rich material removed by precipitation in a liquid having a specific
30 gravity of no more than 1.03, and optionally no more than 1.01 (e.g., water), in which the sorted material does not sink. The lignocellulose-rich material removed from a waste material, or a residue remaining upon fermentation/anaerobic digestion of

lignocellulose, may optionally be added (e.g., returned, if originating from the same waste material) to the sorted material.

In another example, an additional material may optionally comprise a polymeric material obtained by sorting waste material in a liquid having a specific gravity of no more than 1.03, and optionally no more than 1.01 (e.g., water), in which low-density polymers (e.g., polyolefins) do not sink (whereas materials such as lignocellulose, high-density polymers and inorganic materials sink). The sorted polymeric material may be sorted from the same waste material or a different waste material.

Optionally or additionally, the polymeric material is obtained upon subjecting another waste material to a separation according to specific gravity as described herein.

It is to be appreciated that the additional materials may optionally be composite materials, such as laminates (e.g., comprising a polymer in combination with a paper product and/or a metal) and glass-polymer composites (e.g., comprising glass fiber embedded in a polymer). Such composite materials are particularly difficult to recycle by standard methods.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the additional material comprises at least one carbohydrate (e.g., a monosaccharide, a disaccharide, a trisaccharide, an oligosaccharide, a polysaccharide).

Without being bound by any particular theory, it is believed that carbohydrates react during heating and mixing as described herein in a manner which results in processed material with desirable properties.

The carbohydrate(s) may be from any source described herein (e.g., animal or plant material).

In some embodiments of any of the embodiments described herein, carbohydrate(s) is obtained from a liquid (e.g., aqueous solution) which leaches out of the waste material and/or sorted material (e.g., a partially sorted material), for example, upon compression and/or drainage of the material (e.g., as described herein), prior to providing the feedstock, and is collected. Such a liquid may leach out of waste material during or shortly after a shredding process and/or during a separation process described herein, for example, a liquid removed subsequent to a cycle of separating materials according to specific gravity, as described herein (e.g., comprising a carbohydrate in an

aqueous salt solution). A carbohydrate(s) obtained from the liquid may optionally be used as an additional material described herein.

In some embodiments of any of the embodiments described herein, the carbohydrate(s) is separated from at least a portion of the liquid from the waste material and/or sorted material (e.g., a partially sorted material). In some embodiments, the carbohydrate(s) is concentrated prior to being added to the sorted material, for example, by evaporation and/or filtration of the liquid.

In some embodiments of any of the embodiments described herein, the carbohydrate(s) obtained from a liquid (as described herein) may optionally be used as a feedstock material for a process other than the processing of a waste material described herein, for example, for preparation of a polymeric material (e.g., a polysaccharide-containing and/or polylactic acid-containing material). A carbohydrate(s) obtained from a liquid derived from the waste material and/or sorted material (e.g., a partially sorted material) may be processed by techniques known in the art, for example, by heat treatment, fermentation, cross-linking, condensation, and/or polymerization.

In some embodiments of any of the embodiments described herein, the carbohydrate(s) is separated from some or all of the liquid derived from the waste material and/or sorted material (e.g., a partially sorted material) prior to further processing, for example, by concentration and/or purification of the carbohydrate(s) (e.g., as described herein).

In some embodiments of any of the embodiments described herein, the carbohydrate(s) is processed while in liquid derived from the waste material and/or sorted material (e.g., a partially sorted material), that is, without first separating the carbohydrate(s) from the liquid. For example, the liquid may be treated by heating and/or addition of a reagent such as a cross-linking agent, an enzyme, a microorganism, an acid, a base, an organic solvent and/or any other reagent used in the chemical arts for effecting fermentation, cross-linking, condensation, and/or polymerization.

In some embodiments of any of the embodiments described herein, the carbohydrate(s) is processed as described herein so as to produce a polysaccharide-containing polymeric material (e.g., a plastarch material).

In some embodiments of any of the embodiments described herein, the carbohydrate(s) in the liquid are subjected to fermentation (e.g., by a microorganism or

isolated enzymes), so as to convert the carbohydrate(s) to a metabolite, for example, lactic acid. In some embodiments, the metabolite (e.g., lactic acid) in the liquid is then processed as described herein (e.g., to produce polylactic acid).

In some of any of the embodiments pertaining to a method of processing waste material as described herein, the feedstock prior to mixing and heating is a shredded feedstock. Feedstock may optionally be obtained in a shredded form (e.g., in a form of a shredded sorted material and/or additional material as described herein), or the method may optionally further comprise shredding the feedstock prior to the mixing and heating described herein.

Optionally, the feedstock is substantially devoid of relatively large particles. Particles above a certain size may be removed, for example, by sieving.

In some of any of the embodiments pertaining to a method of processing waste material as described herein, solid particles in the feedstock (e.g., shredded feedstock) are less than 50 mm in diameter, optionally less than 20 mm in diameter. In some embodiments, the solid particles are less than 10 mm in diameter. In some embodiments, the solid particles are less than 5 mm in diameter. In some embodiments, the solid particles are less than 2 mm in diameter.

In some of any of the embodiments described herein in the context of a method of processing waste material, the heating of the feedstock is at a temperature of at least 90 °C. In some embodiments, the heating of the feedstock is at a temperature of at least 100 °C. In some embodiments, the heating of the feedstock is at a temperature of at least 110 °C. In some embodiments, the heating of the feedstock is at a temperature of at least 120 °C. In some embodiments, the heating of the feedstock is at a temperature of at least 130 °C. In some embodiments, the heating of the feedstock is at a temperature of at least 140 °C. In some embodiments, the heating of the feedstock is at a temperature of at least 150 °C. In some embodiments, the heating of the feedstock is at a temperature of at least 160 °C.

In some of any of the embodiments described herein in the context of a method of processing waste material, the heating of the feedstock is at a temperature of no more than 230 °C. In some embodiments, the heating of the feedstock is at a temperature of no more than 225 °C. In some embodiments, the heating of the feedstock is at a temperature of no more than 210 °C. In some embodiments, the heating of the feedstock

is at a temperature of no more than 200 °C. In some embodiments, the heating of the feedstock is at a temperature of no more than 190 °C. In some embodiments, the heating of the feedstock is at a temperature of no more than 180 °C.

In some of any of the embodiments described herein in the context of a method
5 of processing waste material, the heating of the feedstock is at a temperature in a range of from 90 °C to 230 °C. In some embodiments, the heating of the feedstock is at a temperature in a range of from 90 °C to 180 °C. In some embodiments, the heating of the feedstock is at a temperature in a range of from 140 °C to 180 °C. In some
10 embodiments, the heating of the feedstock is at a temperature in a range of from 180 °C to 225 °C.

The heating may optionally be at a constant temperature throughout the heating process.

Alternatively, the temperature may vary during the heating process. For example, in exemplary embodiments, the heating is at a temperature of about 110 °C in
15 one stage of the heating process, and from about 180 to about 225 °C in a later stage of the heating process, as is further discussed in detail herein below with regard to repeating cycles of heating and mixing.

Herein, the term “about”, when used in reference to a temperature, indicates ± 10 °C. In some embodiments, “about” indicates ± 5 °C.

20 Subjecting the feedstock to mixing via shear forces may optionally be performed prior to, concomitant with, and/or subsequent to subjecting the feedstock to heating. In exemplary embodiments, subjecting the feedstock to mixing via shear forces is performed concomitant with the feedstock to heating.

For simplicity, the step of subjecting the feedstock to mixing via shear forces
25 and the step of subjecting the feedstock to heating (as these steps are described herein), are referred to herein as “mixing and/or heating”. Thus, the phrase “mixing and/or heating” refers to heating with temperatures described herein and to mixing with shear forces as described herein.

Mixing may be effected by any method which generates shear forces.

30 As used herein and in the art, “shear force” refers to a force which causes a stress in a material in a direction which is parallel to a cross-section of the material.

It is to be appreciated that movement of fluids over a solid surface characteristically incurs a shear force.

Hence, according to some of any of the embodiments described herein in the context of a method of processing waste material, mixing is performed in such a way as to maximize passage of feedstock over solid surfaces. Optionally, solid components with large surface areas (e.g., a screw, a propeller) are utilized to increase shear force.

Optionally, shear forces are generated by a compounder, such as, without limitation, an extruder, an internal mixer (a Banbury® mixer), a co-kneader, and/or a continuous mixer etc.

The shear forces and mixing time should be sufficient such that the obtained processed material is essentially evenly dispersed matter throughout the mass/body thereof.

In some of any of the embodiments described herein in the context of a method of processing waste material, the shear forces are characterized by a shear rate of at least 1 second^{-1} , optionally at least 2 second^{-1} , optionally in a range of from 3 second^{-1} to 300 second^{-1} . In some embodiments the shear rate is in a range of from 1 to 30 second^{-1} . In some embodiments the shear rate is in a range of from 30 to 100 second^{-1} . In some embodiments the shear rate is in a range of from 100 to 200 second^{-1} . In some embodiments the shear rate is in a range of from 200 to 300 second^{-1} .

According to optional embodiments, mixing is effected by rotation of a screw. The screw is optionally in a barrel (e.g., the barrel forming a closed container). The barrel may optionally be heated (e.g., by an electric heater) in order to effect heating along with mixing. Alternatively or additionally, the screw may optionally be heated (e.g., by a flow of heated fluid inside the screw) in order to effect heating along with mixing.

In some of any of the embodiments described herein in the context of a method of processing waste material, mixing is effected by rotation of a screw in an extruder.

An extruder typically comprises a heated barrel containing rotating therein a single or multiple screws. When more than a single screw is used, the screws may be co-rotated or counter-rotated. Screws may be intermeshing, or non-intermeshing. The extrusion apparatus may be a single extruder or combinations of extruders (such as in tandem extrusion) which may be any one of the extruders known in the plastics

industry, including, without limitation, a single screw extruder, a tapered twin extruder, a tapered twin single extruder, a twin screw extruder, a multi-screw extruder. In some embodiments of any of the embodiments described herein relating to an extruder, the extruder is a single screw extruder.

5 In some of any of the embodiments described herein in the context of a method of processing waste material, the extruder is equipped with a venting zone. In some embodiments, the extruder is equipped with more than one venting zone. In some embodiments the nozzle of the extruder is chilled during the extrusion process.

10 In some of any of the embodiments described herein in the context of a method of processing waste material, the method further comprises passing the material being processed through at least one screen during the mixing and/or heating. Optionally, a plurality of screens are used (the screens being the same or different in dimensions), such that the material being processed is passed through screens at more than one stage of the heating and/or mixing.

15 As used herein, the term “screen” encompasses any apparatus having spaces which selectively allows the passage of solid material with sufficiently small dimensions.

 In some embodiments, the spaces in the screen are no more than 10 mm in width. In some embodiments, the spaces in the screen are no more than 5 mm in width.
20 In exemplary embodiments, the spaces are about 3 mm in width.

 Without being bound by any particular theory, it is believed that the use of a screen results in a more homogeneous and non-particulate processed material, by removing solid particles containing materials which do not considerably melt or soften upon heating, in contrast to the bulk of the material being processed.

25 However, the present inventor has found that the use of one or more screens when processing waste material is limited by the tendency of screens to be clogged during processing, for example, by solid materials which the screens are intended to remove, and/or by fluids which are too viscous to readily pass through the screens. Such clogging may require considerably time for cleaning and/or replacing the screens,
30 thereby significantly reducing efficiency of the processing. The present inventor has further uncovered that sorting waste material according to a method described herein considerably reduces clogging of screens, thereby facilitating their use.

Without being bound by any particular theory, it is believed that sorting waste material according to a method described herein reduces clogging by removing materials which remain solid upon heating (e.g., inorganic materials, thermoset synthetic polymers, synthetic polymers having a high melting point), and/or by
5 increasing a proportion of polymers (e.g., polyolefins) which readily melt upon heating (e.g., thereby enhancing flow of the material being processed). It is further believed that the use of feedstock with a relatively high water content (e.g., as described herein) may reduce clogging by decreasing a viscosity of the feedstock.

In some of any of the embodiments described herein in the context of a method
10 of processing waste material, mixing and/or heating is performed under conditions with relatively low oxygen concentrations. Low oxygen concentrations may optionally be obtained by performing the mixing and/or heating in a closed container having a low volume of air. Optionally, the volume of air in the container is less than 30% of the container volume, optionally less than 20% of the container volume, optionally less than
15 10% of the container volume, optionally less than 5% of the container volume, optionally less than 2% of the container volume, and optionally less than 1% of the container volume.

Optionally, air is removed from a closed container by generating a vacuum in the container, in order to lower an oxygen concentration in the container during mixing
20 and/or heating.

Alternatively or additionally, air is removed from a closed container by flushing the container with a gas which comprises little (e.g., less than 20%) or no oxygen (e.g., nitrogen gas, argon gas, carbon dioxide), in order to lower an oxygen concentration in the container during mixing and/or heating.

In some of any of the embodiments described herein in the context of a method
25 of processing waste material, the feedstock is compressed prior to heating and mixing, thereby lowering the volume of air included within the feedstock itself.

An extruder may optionally be used to compress the feedstock. For example, the feedstock may enter a first extruder to be subjected to heating and mixing, while a
30 tandem extruder (e.g., perpendicular to the first extruder) compresses the feedstock entering the first extruder in order to remove air. The tandem extruder may comprise, for example, a conical extruder and/or an internal mixer (e.g., a Banbury® mixer).

Without being bound by any particular theory, it is believed that excessive oxidation reactions may adversely affect the utility of the processed material, and that performing the disclosed process under conditions with relatively low oxygen concentrations is desirable in order to reduce the level of such oxidation reactions. For example, excessive oxidation (e.g., combustion) may break down the solid materials in feedstock to a considerable extent, thereby weakening the obtained processed material.

It is further believed that some of the reactions which advantageously affect the utility of the processed material are endothermic, in sharp contrast to exothermic oxidation reactions (e.g., combustion). An additional advantage of limiting exothermic oxidation reactions is that excessive exothermic reactions may be difficult to control.

In some of any of the embodiments described herein in the context of a method of processing waste material, the method further comprises removing gases released during mixing and/or heating. The gases include steam (gaseous water), and may further include additional gases, such as vapors of volatile organic compounds.

Optionally, removal of gases is effected using suction, e.g., via a pump.

Optionally, the method comprises removing gases (as described herein) more than once (i.e., at more than one stage of the process), for example, twice, three times, four times, and even more. In exemplary embodiments, gases are removed twice.

It has been demonstrated that removal of gases during the process affects the properties of the obtained processed material. For example, removal of steam during the process facilitates a gradual reduction in water content during processing from the relatively high concentration found in the feedstock (e.g., as described herein) to a low concentration (e.g., as described herein) which allows for beneficial physicochemical properties of the processed material. In addition, removal of gases during the process prevents formation of excessive pressure, and thereby allows for a thorough, long-lasting process, which further enhances the physicochemical properties of the processed material.

In some of any of the embodiments described herein in the context of a method of processing waste material, the processed material obtained by mixing and/or heating (e.g., as described hereinabove) is subjected to at least one additional cycle of mixing and/or heating, as described herein, so as to obtain at least one additional processed material. Thus, the method may comprise, for example, 2 cycles, 3 cycles, 4 cycles, 5

cycles, and even more, of mixing and/or heating as described herein, wherein each cycle produces a new processed material, until a final processed material is produced by the final cycle.

In exemplary embodiments, the method comprises two cycles of mixing and/or heating, as described herein. A first processed material obtained from the first cycle of mixing and/or heating is subjected to a second cycle of mixing and/or heating, thereby producing a second, and final, processed material.

The various cycles of mixing and/or heating may be effected by moving the material being processed between different zones for mixing and/or heating.

Optionally, each of the cycles of mixing and/or heating further comprises removing gases (e.g., as described herein) released during the cycle. Thus, the method may optionally comprise sequential cycles (e.g., 2 cycles), each comprising mixing and/or heating, as described herein and removing gases, as described herein.

Alternatively, one or more cycles comprise both mixing and/or heating and removing gases and the other cycles comprise only mixing and/or heating, as described herein.

Optionally, a final cycle of mixing and/or heating does not comprise removing gases released during the cycle (e.g., wherein little or no gases are released during the final cycle). Thus, the method may optionally comprise sequential cycles (e.g., 2 cycles) of mixing and/or heating and removing gases, followed by a final cycle (e.g., a third cycle) of mixing and/or heating without removing gases.

Thus, an exemplary process according to some embodiments of the present invention is effected by subjecting the feedstock as described herein to mixing and to heating, at certain conditions (e.g., certain mixing technology and a certain temperature, as described hereinabove, which can be referred to in this context as a first temperature).

In some of any of the embodiments described herein in the context of a method of processing waste material, upon the mixing and heating, a first removal of gases is effected, as described herein.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the resulting processed material is then subjected to a second cycle of mixing and heating, as described herein, at certain

conditions (e.g., certain mixing technology and a certain temperature, as described hereinabove, which can be referred to in this context as a second temperature.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, upon the mixing and heating, a second
5 removal of gases is effected, as described herein.

In some embodiments, the above is repeated for as many cycles as desired.

Thus, in some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the processed material resulting from a second cycle of mixing and heating (e.g., as described hereinabove) is then subjected
10 to a third cycle of mixing and heating, as described herein, at certain conditions (e.g., certain mixing technology and a certain temperature, as described hereinabove, which can be referred to in this context as a third temperature).

In each cycle, the conditions for mixing and heating can be the same or different.

15 In each cycle, the removal of gases can be effected or not.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, mixing is the same in each of cycles.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the first, second, third, and so on, temperature
20 is different.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the first temperature is higher than the second temperature.

In some embodiments of any of the embodiments described herein in the context
25 of a method of processing waste material, the first temperature is lower than the second temperature.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the second temperature is higher than the third temperature.

30 In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the second temperature is lower than the third temperature.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the first temperature is higher than the third temperature.

5 In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the first temperature is lower than the third temperature.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the third temperature is about 150 °C.

10 In an exemplary process, mixing is effected by a screw of an extruder, the first temperature is about 110 °C and the second temperature is from about 180 to about 225 °C.

In some embodiments of this exemplary process, the first temperature and second temperature are achieved by the same heating mechanism, and the difference between the two temperatures is a result of changes in the properties of the material
15 being processed (e.g., the lower second temperature reflecting an increasingly endothermic reaction).

In this exemplary process, removal of gases is effected within each cycle.

In an exemplary process, removal of gases is effected by a pump.

20 In some of any of the embodiments described herein in the context of a method of processing waste material, the total duration (i.e., including all cycles) of heating of feedstock is at least 5 minutes. In some embodiments, total duration of heating of feedstock is at least 10 minutes. In some embodiments, the total duration of heating of feedstock is at least 15 minutes. In some embodiments, the total duration of heating of feedstock is at least 20 minutes. In some embodiments, the total duration of heating of
25 feedstock is at least 30 minutes. In some embodiments, the total duration of heating of feedstock is at least 40 minutes. In some embodiments, the total duration of heating of feedstock is at least 60 minutes.

30 In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, upon the first mixing and heating described hereinabove, water in the material being processed is eliminated via removal of steam formed by the heating and/or mixing (e.g., via removal of evaporated water during removal of gases). In addition, water may optionally be further eliminated via chemical

reactions (e.g., hydrolysis, in which a water molecule reacts with another molecule, resulting in cleavage of a covalent bond). Consequently, the water content is reduced during the process. Optionally, mixing and/or heating are performed until the water content of the material being processed is reduced to a desired level.

5 Water content may be measured, for example, using a commercially available moisture gauge.

As the mixing and/or heating process results in evaporation of water, mixing and/heating is optionally performed at a suitable temperature and a suitable length of time which result in sufficient evaporation of water. In addition, gas removal is
10 optionally performed at a rate suitable for eliminating substantially all of the generated water vapor, until the water content of the waste material is reduced to a desired level.

In some of any of the embodiments described herein in the context of a method of processing waste material, the majority of the water in the feedstock is eliminated via a first gas removal, such that the water content of the processed material obtained after
15 the first gas removal is less than 50% of the water content of the feedstock before effecting the process. Optionally, any additional gas removals effect a further reduction of the water content to a low concentration such as described herein (e.g., less than 1 weight percent).

In some of any of the embodiments described herein in the context of a method
20 of processing waste material, the method described herein is effected such that the obtained processed material has a water content of less than 1 weight percent. In some embodiments, the water content of the processed material is less than 0.1 weight percent.

In some of any of the embodiments described herein in the context of a method
25 of processing waste material, mixing, heating and removal of gases are performed until a water content of the processed material is less than 0.03 weight percent. In some embodiments, mixing, heating and removal of gases are performed until a water content of the processed material is less than 0.01 weight percent. In some embodiments, mixing, heating and removal of gases are performed until a water content of the
30 processed material is less than 0.003 weight percent. In some embodiments, mixing, heating and removal of gases are performed until a water content of the processed material is less than 0.001 weight percent.

In some of any of the embodiments described herein in the context of a method of processing waste material, the method further comprises contacting the waste material or sorted waste material (e.g., as described herein) with an acidic substance (e.g., a solid or liquid substance comprising an acid), to thereby provide a feedstock that is more acidic than it would have been in the absence of the contacting with the acidic substance. In some embodiments, the additional material(s) added to the sorted material, as described herein, comprise the acidic substance.

Without being bound by any particular theory, it is believed that acid enhances reactions during the mixing and heating process described herein, in an advantageous manner.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the acidic solution is sufficiently acidic so as to result in cleavage of lignocellulose in the waste material, sorted material and/or feedstock to smaller units (e.g., cleavage of polysaccharide to smaller polysaccharide, oligosaccharide, trisaccharide, disaccharide and/or monosaccharide units), prior to and/or during mixing and heating as described herein.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, sorted material and/or feedstock is contacted with the acidic substance (e.g., an acidic liquid), for example, so as not to wash out the acidic substance during separation in a liquid as described herein, which may reduce an amount of acid during mixing and heating and/or deleteriously expose devices involved with separation to an acid.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the acidic substance is mixed with the waste material prior to sorting.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the waste material, sorted material and/or feedstock is submerged in an acidic liquid, and removed from the acidic liquid, with a portion of the acidic liquid remaining adhered to the material. In some embodiments, the waste material, sorted material and/or feedstock is removed from the liquid using a screw configured for removing solids from a liquid (e.g., an inclined screw). In some

embodiments, the waste material, sorted material and/or feedstock is removed from the liquid by filtration.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the acidic substance comprises hydrochloric acid.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, the acidic substance comprises an acidic aqueous solution. In some embodiments, the acidic aqueous solution is characterized by a pH of less than 4. In some embodiments, the acidic aqueous solution is characterized by a pH of less than 3. In some embodiments, the acidic aqueous solution is characterized by a pH of less than 2. In some embodiments, the acidic aqueous solution is characterized by a pH of less than 1. In some embodiments, the acidic aqueous solution is characterized by a pH of less than 0 (i.e., a negative pH).

As described in the Examples herein, the processed material obtainable by heating and mixing as described herein may be thermoplastic and consequently moldable.

Herein, "thermoplastic" refers to an ability to undergo a reversible transition to a deformable state when heated. The deformable state may be, for example, a liquid which results from melting upon heating, or a softened solid or semi-solid, which may be readily deformed (as plastic deformation) by application of pressure.

Herein, the term "moldable" refers to an ability to deform a shape of a material (e.g., upon heating of a thermoplastic material) in a controllable manner, so as to obtain a product with a pre-determined shape (e.g., upon cooling of a thermoplastic material after molding).

In some of any of the embodiments described herein in the context of a method of processing waste material, the method further comprises molding the processed material. Molding may be according to any technique used in the art for molding thermoplastic substances.

In some embodiments, the molding comprises extrusion molding. In some embodiments, the molding comprises injection molding. In some embodiments, the molding comprises rotation molding. In some embodiments, the molding comprises compression molding.

In some embodiments, an additional material, as described herein, is mixed with the processed material prior to or during molding the processed material.

In this manner, articles of a defined configuration may be manufactured. For example, flower pots, housing siding, deck materials, flooring, furniture, laminates, pallets, septic tanks and the like can be prepared by molding or otherwise reshaping the processed material.

Molding may optionally be effected by heating the processed material at a temperature of at least 90 °C, optionally at least 100 °C, optionally at least 110 °C, optionally at least 120 °C, optionally at least 130 °C, optionally at least 140 °C, optionally at least 150 °C, optionally at least 160 °C, optionally at least 170 °C, and optionally at least 180 °C.

In some embodiments, molding is effected at a temperature that ranges from about 50 °C to about 200 °C, or from about 90 °C to about 180 °C. Any intermediate value is contemplated.

Such heating may be effected by maintaining the heating used to process the feedstock, as described hereinabove, and/or by reheating the processed material subsequent to processing of the feedstock by heating, and optionally mixing, as described herein.

Using the process described herein results in a processed material as described herein. The composition of the processed material will be similar to the feedstock composition (e.g., a feedstock composition described herein) with the water removed, but will typically be somewhat different than the feedstock composition due to chemical reactions induced, for example, by the heating and mixing described herein.

According to optional embodiments, the processed material comprises a polymeric material (e.g., a non-particulate polymeric material).

According to another aspect of some embodiments of the invention, there is provided a processed material which is a polymeric material (e.g., non-particulate polymeric material) obtainable by any of the processes as described herein. The polymeric material is optionally and preferably a thermoplastic polymeric material.

Herein "polymeric material" refers to a material in which a concentration of polymers is at least 50 weight percents of the material. The polymers may be synthetic polymers or polymers derived from biomass (e.g., plant material and animal material).

Thus, in some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, at least 50 weight percents of the processed material consists of polymers. In some embodiments, at least 60 weight percents of the processed material consists of polymers. In some
5 embodiments, at least 70 weight percents of the processed material consists of polymers. In some embodiments, at least 80 weight percents of the processed material consists of polymers. In some embodiments, at least 90 weight percents of the processed material consists of polymers.

The remainder of the processed material may comprise, for example, ash,
10 residual liquids (e.g., water), small organic compounds (e.g., sugars, furfural, amino acids, lipids), and/or small amounts of inorganic materials present in the waste material (e.g., metals, sand, stone, glass and/or ceramic, and/or an inorganic salt derived from an aqueous liquid used in separation, as described herein).

In some of any of the embodiments described herein, the polymeric material is a
15 thermoplastic material. It is to be understood that the polymeric material may comprise a variety of polymers, and that it is meant that the polymeric material as a whole is thermoplastic, and that the polymeric material may comprise polymers which are not characterized as being thermoplastic *per se*.

Without being bound by any particular theory, it is believed that polymers in the
20 processed material obtained according to embodiments of the invention are largely responsible for the thermoplastic properties of waste material processed as described herein.

The removal of inorganic materials and optional addition of an inorganic salt as described herein, affect the elemental composition of the obtained processed material,
25 for example, by increasing a percentage of carbon, oxygen, nitrogen, hydrogen and/or elements in the salt (e.g., alkali metals and/or halogens), particularly carbon and hydrogen (e.g., because oxygen and nitrogen may be depleted due to their presence in inorganic materials and/or organic materials having a relatively high specific gravity) and/or by decreasing a percentage of other atoms.

Without being bound by any particular theory, it is believed that the obtained
30 elemental composition is associated with desirable properties of the processed material.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a concentration of carbon in the processed material is at least 55 weight percents. In some embodiments, the concentration of carbon is at least 57.5 weight percents. In some embodiments, the concentration of carbon is at least 60 weight percents. In some embodiments, the concentration of carbon is at least 62.5 weight percents. In some embodiments, the concentration of carbon is at least 65 weight percents. In some embodiments, the concentration of carbon is at least 67.5 weight percents.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a concentration of carbon in the processed material is at least 55 weight percents. In some embodiments, the concentration of carbon is at least 57.5 weight percents. In some embodiments, the concentration of carbon is at least 60 weight percents. In some embodiments, the concentration of carbon is at least 62.5 weight percents. In some embodiments, the concentration of carbon is at least 65 weight percents. In some embodiments, the concentration of carbon is at least 67.5 weight percents.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a total concentration of carbon and hydrogen in the processed material is at least 65 weight percents. In some embodiments, the concentration of carbon and hydrogen is at least 67.5 weight percents. In some embodiments, the concentration of carbon and hydrogen is at least 70 weight percents. In some embodiments, the concentration of carbon and hydrogen is at least 72.5 weight percents. In some embodiments, the concentration of carbon and hydrogen is at least 75 weight percents. In some embodiments, the concentration of carbon and hydrogen is at least 77.5 weight percents. In some embodiments, the concentration of carbon and hydrogen is at least 80 weight percents.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a concentration of oxygen in the processed material is at least 20 weight percents. In some embodiments, the concentration of oxygen is at least 22 weight percents. In some embodiments, the concentration of oxygen is at least 24 weight percents. In some embodiments, the concentration of oxygen is at least 26 weight percents. In some embodiments, the

concentration of oxygen is at least 28 weight percents. In some embodiments, the concentration of oxygen is at least 30 weight percents.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a total concentration of carbon and oxygen in the processed material is at least 80 weight percents. In some
5 embodiments, the concentration of carbon and oxygen is at least 82 weight percents. In some embodiments, the concentration of carbon and oxygen is at least 84 weight percents. In some embodiments, the concentration of carbon and oxygen is at least 86 weight percents. In some embodiments, the concentration of carbon and oxygen is at least 88 weight percents. In some embodiments, the concentration of carbon and
10 oxygen is at least 90 weight percents.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a total concentration of carbon, hydrogen and oxygen in the processed material is at least 90 weight percents.
15 In some embodiments, the concentration of carbon, hydrogen and oxygen is at least 92 weight percents. In some embodiments, the concentration of carbon, hydrogen and oxygen is at least 94 weight percents. In some embodiments, the concentration of carbon, hydrogen and oxygen is at least 96 weight percents. In some embodiments, the concentration of carbon, hydrogen and oxygen is at least 98 weight percents.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a total concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms in the processed material is at least 93 weight percents. In some embodiments, the concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms is at least 94 weight
25 percents. In some embodiments, the concentration carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms is at least 95 weight percents. In some embodiments, the concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms is at least 96 weight percents. In some embodiments, the concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms is at least 97 weight
30 percents. In some embodiments, the concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms is at least 98 weight percents. In some embodiments, the concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and

halogen atoms is at least 99 weight percents. It is to be appreciated that a relatively high total concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms indicates a relatively low concentration of inorganic material other than water-soluble inorganic salts (which typically comprise an alkali metal cation and/or a halogen anion).

In some embodiments, non-hydrogen atoms (e.g., any atoms other than hydrogen) are quantified. This allows the use of elemental analysis techniques which are not effective at detecting hydrogen atoms (e.g., as exemplified herein).

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, at least 95 % of the non-hydrogen atoms in the processed material are carbon or oxygen atoms. In some embodiments, at least 96 % of the non-hydrogen atoms are carbon or oxygen. In some embodiments, at least 97 % of the non-hydrogen atoms are carbon or oxygen. In some embodiments, at least 98 % of the non-hydrogen atoms are carbon or oxygen.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, at least 97 % of the non-hydrogen atoms in the processed material are carbon, oxygen, nitrogen, alkali metal or halogen atoms. In some embodiments, at least 97.5 % of the non-hydrogen atoms are carbon, oxygen, nitrogen, alkali metal or halogen atoms. In some embodiments, at least 98 % of the non-hydrogen atoms are carbon, oxygen, nitrogen, alkali metal or halogen atoms. In some embodiments, at least 98.5 % of the non-hydrogen atoms are carbon, oxygen, nitrogen, alkali metal or halogen atoms. In some embodiments, at least 99 % of the non-hydrogen atoms are carbon, oxygen, nitrogen, alkali metal or halogen atoms. In some embodiments, at least 99.5 % of the non-hydrogen atoms are carbon, oxygen, nitrogen, alkali metal or halogen atoms.

It is to be appreciated that when determining percentage of atoms, as opposed to weight percentages, the elements described herein represent a particularly high percentage, because atoms associated with inorganic materials (e.g., silicon, metals) tend to be heavier and atoms such as carbon, hydrogen and oxygen, and are therefore disproportionately represented in weight percentages.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a molar concentration of alkali

metals in the processed material is at least 50 % higher than a molar concentration of alkali metals in the dry weight of the waste material. In some embodiments, the molar concentration of alkali metals is at least 100 % higher (i.e., two-fold). In some embodiments, the molar concentration of alkali metals is at least 150 % higher. In some
5 embodiments, the molar concentration of alkali metals is at least 200 % higher. In some embodiments, the molar concentration of alkali metals is at least 300 % higher. In some embodiments, the molar concentration of alkali metals is at least 400 % higher. In some
embodiments, the molar concentration of alkali metals is at least 600 % higher. In some
10 embodiments, the molar concentration of alkali metals is at least 900 % higher (i.e., ten-fold).

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material, a molar concentration of halogens in the processed material is at least 50 % higher than a molar concentration of halogens in the dry weight of the waste material. In some embodiments, the molar
15 concentration of halogens is at least 100 % higher. In some embodiments, the molar concentration of halogens is at least 150 % higher. In some embodiments, the molar concentration of halogens is at least 200 % higher. In some embodiments, the molar concentration of halogens is at least 300 % higher. In some embodiments, the molar concentration of halogens is at least 400 % higher. In some
20 embodiments, the molar concentration of halogens is at least 600 % higher. In some embodiments, the molar concentration of halogens is at least 900 % higher.

Herein, the phrase "molar concentration" refers to a number (e.g., in mole units) of molecules or atoms (e.g., alkali metal atoms, halogen atoms) per volume.

Herein, a molar concentration in the dry weight of waste material refers to a
25 molar concentration in the waste material when dried (e.g., by evaporation) until substantially dry (e.g., no more than 1 weight percent water), for example, wherein a water content of the dried waste material is substantially the same as the water content of the process material to which it is being compared.

In some of any of the embodiments described herein in the context of a method
30 of processing waste material and/or a processed material, a melt-flow index (MFI) of the processed material is at least 1 gram per 10 minutes at a temperature of 190 °C (the melt-flow index being determined according to ISO 1133 standards). In some

embodiments, the MFI is at least 1.5 grams per 10 minutes. In some embodiments, the MFI is at least 2 grams per 10 minutes. In some embodiments, the MFI is at least 2.5 grams per 10 minutes. In some embodiments, the MFI is at least 3 grams per 10 minutes. In some embodiments, the MFI is at least 3.5 grams per 10 minutes. In some
5 embodiments, the MFI is at least 4 grams per 10 minutes. In some embodiments, the MFI is no more than 10 grams per 10 minutes (e.g., from 1 to 10 grams per 10 minutes). In some embodiments, the MFI is no more than 8 grams per 10 minutes (e.g., from 1 to 8 grams per 10 minutes). In some embodiments, the MFI is no more than 6 grams per 10 minutes (e.g., from 1 to 6 grams per 10 minutes).

10 Without being bound by any particular theory, it is believed that a melt-flow index of at least 1 gram per 10 minutes is associated with a relatively high polymeric nature of the processed material (e.g., a polymeric material as described herein), particularly a thermoplastic polymeric nature of the processed material.

It is further believed that thermoplasticity of the processed material (e.g., as
15 indicated by a MFI as described herein) is associated with relative flowability of the feedstock during processing by heating and mixing, and that such flowability during processing by heating and mixing advantageously allows for the effective use of screens during processing for removing inhomogeneities (e.g., solid material), resulting in a more homogeneous and non-particulate processed material. In contrast, a feedstock
20 with a lower flowability could tend to clog the screens, thereby preventing the efficient use of screens to further enhance homogeneity and reduce particulate levels of the processed material.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material is less brittle at low
25 temperatures (e.g., less susceptible to cold-cracking), optionally at 10 °C, 0 °C, -10 °C, and/or -20 °C, than a material obtained by processing (unsorted) waste material instead of sorted material, that is, by processing a feedstock comprising the waste material instead of sorted material. In some embodiments, the increased resistance to cold-cracking is characterized by higher impact strength (e.g., Izod impact strength, Charpy
30 impact strength) at a temperature of 10 °C, 0 °C, -10 °C, and/or -20 °C.

In some of any of the embodiments described herein in the context of a method of processing waste material and/or a processed material is more resistant to combustion

(e.g., combustion occurs at a higher temperature) than a material obtained by processing (unsorted) waste material instead of sorted material, that is, by processing a feedstock comprising the waste material instead of sorted material.

Without being bound by any particular theory, it is believed that reduced
5 brittleness at low temperature and/or higher resistance to combustion are associated with a lower degree of inhomogeneities, for example, inhomogeneities (e.g., metals, minerals) which induce crack formation (e.g., increased brittleness) and/or which induce temperature inhomogeneities upon heating that facilitate combustion.

In some of any of the embodiments described herein in the context of a method
10 of processing waste material, the processed material is characterized as being largely soluble in appropriate solvents, for example, in organic solvents. It is to be appreciated that being soluble “in organic solvents” may refer to dissolution using multiple solvents (e.g., some of the processed material is soluble in one solvent and some is soluble in another solvent), and does not necessarily indicate that all of the material can be
15 dissolved in a single solvent.

Such solubility is optionally associated with a high amount of polymers and/or a low amount of inorganic materials.

In some embodiments of any of the embodiments described herein in the context of a method of processing waste material, at least 90% of the processed material is
20 soluble in organic solvents. In some embodiments, at least 95% of the processed material is soluble in organic solvents. In some embodiments, at least 99% of the processed material is soluble in organic solvents. In some embodiments, at least 99.9% of the processed material is soluble in organic solvents.

It is to be appreciated that low amounts of non-soluble material renders a
25 processed material more suitable for being combined with various polymers (e.g., polyethylene, polypropylene), which may become fragile when combined with excess amounts (e.g., more than 5%, more than 8%) of non-soluble (e.g., inorganic) materials.

Without being bound by any particular theory, it is believed that carbohydrates such as polysaccharides in the feedstock, at least a portion of which originate in waste
30 material, undergo hydrolysis when subjected to heating and mixing as described herein, resulting in a mixture of monosaccharides, disaccharides, trisaccharides and/or oligosaccharides which may comprise, for example, glucose (which may be derived, for

example, from cellulose, hemicellulose and/or starch), and/or xylose, mannose, galactose, rhamnose, and/or arabinose (which may be derived, for example, from hemicellulose). The substantial degree of hydrolysis is believed to be due to the initial presence of substantial amounts of water in the feedstock (such as described herein). In addition, pyrolysis of polysaccharides may also result in monosaccharides, disaccharides, trisaccharides and/or oligosaccharides.

It is further believed that carbohydrates in the feedstock further undergo polymerization and other forms of covalent bond formation (e.g., by caramelization and/or Maillard type reactions), resulting in the formation of polymeric materials (e.g., carbohydrates and derivatives thereof) which are not present in the feedstock prior to processing. It is further believed that pyrolysis further alters the structure of polymeric materials in the feedstock during processing, thereby further forming polymeric materials which are not present in the feedstock prior to processing.

The degree of hydrolysis is believed to gradually decrease as the material being processed becomes progressively drier upon heating during processing, whereas the relative degree of other reactions (e.g., caramelization, pyrolysis) is believed to gradually increase as the material being processed becomes progressively drier.

Thus, in some of any of the embodiments described herein in the context of a method of processing waste material, the processed polymeric material comprises polymers other than those present in the feedstock prior to processing. In some embodiments, at least 1 weight percent of the polymeric material in the processed material consists of polymers other than those present in the feedstock prior to processing. In some embodiments, at least 5 weight percents of the polymeric material consists of polymers other than those present in the feedstock. In some embodiments, at least 10 weight percents of the polymeric material consists of polymers other than those present in the feedstock. In some embodiments, at least 20 weight percents of the polymeric material consists of polymers other than those present in the feedstock. In some embodiments, at least 50 weight percents of the polymeric material consists of polymers other than those present in the feedstock. In some embodiments, at least 75 weight percents of the polymeric material consists of polymers other than those present in the feedstock.

According to some embodiments of any of the embodiments described herein, the processing described herein results in a loss of the structure which characterizes plant and animal material in the waste material. For example, microscopic examination of plant and animal material typically shows structures such as cell walls and fibrous structures (e.g., collagen fibers), whereas in the processed material, such structures are optionally substantially absent upon microscopic examination. In some embodiments, osmotic stress induced by a solute (e.g., a salt) in a solution used for separating according to specific gravity (e.g., as described herein) facilitates loss of the structure which characterizes plant and animal material, by altering cell structure (e.g., cell volume). Such osmotic stress may occur during separation according to specific gravity and/or after separation according to specific gravity (e.g., due to solute remaining in the sorted material).

Without being bound by any particular theory, it is believed that loss of the original structure of plant and/or animal material reduces the brittleness and enhances the thermoplasticity of the processed material.

In some embodiments of any of the embodiments described herein in the context of a processed material, the processed material (e.g., polymeric material) described herein is characterized by a density below 1.2 gram/cm³. In some embodiments, the density is below 1.15 gram/cm³. In some embodiments, the density is below 1.1 gram/cm³. In some embodiments, the density is below 1.05 gram/cm³. In some embodiments, the density is below 1.0 gram/cm³.

Without being bound by any particular theory it is believed that separation according to specific gravity, as described herein, is particularly likely to result in a processed material characterized by a relatively low density (e.g., below 1.2 gram/cm³), as compared to other materials made by processing waste materials, as high density materials are separated from the waste material prior to heating and mixing as described herein.

As described herein, the processed material obtained by the process described herein may be useful for a variety of purposes, such as making plastic products, and thus facilitates the beneficial recycling of the waste material.

In some embodiments of any of the embodiments described herein, the process described herein allows for disposal of a hazardous material (e.g., a toxic compound, a

radioactive compound). A feedstock material comprising a hazardous material, for example, sorted material which has been mixed with an additional material that comprises a hazardous material (e.g., a toxic sludge) is processed as described herein so as to provide a processed material in the form of a solid matrix, in which the hazardous material is embedded. A degree of leaching of the hazardous material from the solid matrix is low, such that the hazardous material is safely contained.

According to optional embodiments, at least 10 weight percents of the processed material consists of one or more synthetic polymers, for example, synthetic polymers present in the waste material prior to processing (e.g., plastic products). In some embodiments, at least 15 weight percents of the processed material consists of one or more synthetic polymers. In some embodiments, at least 20 weight percents of the processed material consists of one or more synthetic polymers. In some embodiments, at least 30 weight percents of the processed material consists of one or more synthetic polymers.

The processed material (e.g., polymeric material) described herein may optionally be initially formed into pellets and the like and stored before further processing it into usable articles (e.g., an article-of-manufacturing described herein). The further processing may include injection molding, compression molding or other article fabricating processes. Further processing may also include mixing virgin or recycled plastic with the processed material which may be in the form of pellets or in any other suitable form. This mixture can then be formed into usable objects (e.g., an article-of-manufacturing described herein).

Mixture of various materials (e.g., virgin or recycled plastic) with the processed material (e.g., polymeric material) described herein may be in order to meet desired specifications, e.g., with respect to physical properties, cost, etc. For example, an elastic material may be mixed with the processed material to provide enhanced elasticity, a rigid material may be mixed with the processed material to provide enhanced rigidity, a particularly cheap material may be mixed with the processed material to reduce costs, and so forth.

In some of any of the embodiments described herein, the processed material (e.g., polymeric material) described herein is combined with an additional polymeric material (e.g., plastic).

The processed material (e.g., polymeric material) described herein, as well as a material obtained by mixing the processed material with an additional material (e.g., a plastic), may optionally be further processed through a variety of industrial processes known in the art, to form a variety of semi-finished or finished products.

5 According to another aspect of some embodiments of the invention, there is provided an article-of-manufacturing formed from the processed material (e.g., polymeric material) described herein.

In some embodiments, the article-of-manufacturing is formed by molding the processed material (e.g., polymeric material) described herein (e.g., according to a
10 process described herein).

Non-limiting examples include building material, panels, boards, pallets, pots, and many others.

The processed material (e.g., polymeric material) of embodiments of the invention related to articles of manufacturing may be the sole component or may be in a
15 combination with one or more additional materials, such as a polymer, a compatible polymer blend (a stable blend of immiscible polymers which bind to one another) and/or a miscible polymer blend (a homogenous blend of miscible polymers). The processed material may be combined with an additional material by adhering to and/or being blended with each of the additional material(s). Optionally, the additional material
20 is a plastic (e.g., a polymer, a compatible polymer blend or a miscible polymer blend described herein).

The additional material may optionally be a sorted material obtained by sorting the waste same waste material (e.g., using a different process) and/or a sorted material obtained by sorting a different waste material. For example, an additional material may
25 optionally be a polymeric material obtained by sorting waste material in a liquid having a specific gravity of no more than 1.03, and optionally no more than 1.01 (e.g., water), in which low-density polymers (e.g., polyolefins) do not sink (whereas materials such as lignocellulose, high-density polymers and inorganic materials sink).

In accordance with some embodiments, the article-of-manufacturing may
30 include also laminates adhered to each other, where at least one layer comprises the processed material (e.g., polymeric material) described herein. Such multi-layer structures may be obtained by lamination, co-calendering, co-compression, co-

extrusion or tandem extrusion of two or more materials (one being the processed material of embodiments of the invention) so as to form the multi-layer product.

As the articles-of-manufacturing described herein comprise processed material derived from waste material, and in some embodiments may consist essentially of such processed material, they may be conveniently recycled by including the article-of-manufacturing as a waste material which is subjected to the process described herein. Thus, the articles-of-manufacturing described herein are particularly easy to recycle.

According to another aspect of embodiments of the invention, there is provided a use of a waste material for the production of an article-of-manufacturing described herein. The waste material is optionally processed as described herein, so as to produce a processed material (e.g., polymeric material) described herein. Optionally, the use further comprises processing the processed material as described herein (e.g., by molding the material as described herein).

According to another aspect of embodiments of the invention there is provided a system for sorting a waste material. The system comprises at least one separator configured for separating materials in waste material according to specific gravity (e.g., as described herein), to thereby obtain a sorted material (e.g., a sorted material described herein), for example, a sorted material enriched in material having a specific gravity within a pre-selected range (e.g., as described herein). In some embodiments, sorted material contains at least 90 weight percents of a material having a specific gravity within a pre-selected range (e.g., as described herein).

Herein, the terms "separator" and "separating chamber", which are interchangeably used herein, refer to a device containing a liquid selected such that a portion of the waste material sinks (e.g., a liquid as described herein), thereby being capable of effecting a cycle of separation of inputted material into a relatively high-specific gravity material and relatively low-specific gravity material (e.g., as described herein).

In some embodiments of any of the embodiments pertaining to a system described herein, one or more separator(s) is configured for removing material which sinks in the liquid. The removed material may be transferred, for example, to a bin adapted for receiving removed materials (e.g., inorganic materials, thermoset polymers,

PET, PTFE, PVC). In some embodiments, the separator(s) is further configured for conveying material which does not sink to another component of the system.

In some embodiments of any of the embodiments pertaining to a system described herein, one or more separator(s) is configured for removing material which floats in the liquid. The removed material may be transferred, for example, to a bin adapted for receiving removed materials. In some embodiments, the separator(s) is further configured for conveying material which does not float to another component of the system.

In some embodiments of any of the embodiments pertaining to a system described herein, one or more separator(s) is configured for removing material which floats in the liquid and/or material which sinks in the liquid, the configuration of the separator(s) being controllable and reversible.

In some embodiments of any of the embodiments pertaining to a system described herein, the system is configured for sorting a shredded waste material (e.g., as described herein), for example, waste material subjected to crushing (e.g., by a hammer mill).

In some embodiments of any of the embodiments pertaining to a system described herein, the system further comprises at least one shredder configured for shredding the waste material (e.g., as described herein).

In some embodiments of any of the embodiments pertaining to a system described herein, the system is configured such that at least one separator and at least one shredder are in operative communication in tandem, such that the system is configured for performing at least one separation according to specific gravity and at least one shredding process in a desired sequence (e.g., a sequence described herein).

In some embodiments of any of the embodiments pertaining to a system described herein, the system is configured for shredding the waste material prior to contacting the waste material with the liquid of a separator (e.g., as described herein).

In some embodiments of any of the embodiments pertaining to a system described herein, the system is configured for shredding the sorted material subsequent to contacting the waste material with the liquid of a separator (e.g., as described herein). Such a sorted waste material may be a partially sorted waste material, that is, a sorted material for which further sorting (e.g., in a separator as described herein) is intended;

or a final sorted waste material, that is, a sorted material for which no further sorting is intended.

In some embodiments of any of the embodiments pertaining to a system described herein, the system comprises at least two separators, a first separator
5 configured for separating materials according to specific gravity as described herein, to thereby obtain a partially sorted material, and at least one additional separator configured for subjecting the partially sorted material to at least one additional cycle of separating materials according to specific gravity (e.g., as described herein). In some
10 embodiments, the system further comprises at least one shredder configured for shredding the partially sorted waste material and/or the sorted waste material subsequent to contact with liquid of any one or more of the separators (e.g., to effect a sequence of separating and shredding described herein).

Different separators in a system may contain the same liquid or different liquids. The liquid of each separator is preferably selected such that a portion of inputted waste
15 material or partially sorted material sinks therein.

In some embodiments of any of the embodiments pertaining to a system described herein, the system comprises at least one plurality of separators and/or at least one plurality of shredders configured to operate in parallel. In such embodiments, the plurality of separators and/or plurality of shredders may be configured to perform
20 essentially the same operation, which may allow, for example, a greater throughput of material for such an operation.

In some embodiments of any of the embodiments pertaining to a system described herein, the system further comprises a monitor adapted for monitoring a composition and/or specific gravity of the liquid in one or more separators. In some
25 embodiments, the monitor is configured to adjust a composition and/or specific gravity of the liquid, for example, for maintaining a specific gravity at a predetermined value (e.g., within a predetermined range). In some embodiments, the monitor is configured for controlling entry of water and/or additional substance such as a solute (e.g., a salt described herein) into the separator liquid, to thereby adjust the composition and/or
30 specific gravity of the liquid.

In some embodiments of any of the embodiments pertaining to a system described herein, the system comprises at least one apparatus (e.g., an oil-water

separator described herein) configured for separating oils from a liquid of one or more separators, and optionally collecting oils. Such an apparatus may be configured to remove oils from a separator (e.g., by skimming) and/or from liquid processed outside a separator (e.g., liquid separated from the sorted material outside of a separator, according to any of the respective embodiments described herein).

In some embodiments of any of the embodiments pertaining to a system described herein, the system further comprises an apparatus configured for separating at least a portion of liquid from a sorted material by compression. In some embodiments, the apparatus comprises a screw press. The liquid being separated may comprise, for example, a combination of liquid used for separating according to specific gravity (according to any of the respective embodiments described herein) and liquid derived from the source waste material (e.g., aqueous liquids and oils).

In some embodiments of any of the embodiments pertaining to a system described herein, an apparatus configured for separating liquids from a sorted material by compression is configured to receive material from at least one shredder described herein. In some embodiments, the apparatus comprises a screw press.

In some embodiments of any of the embodiments pertaining to a system described herein, the system comprises at least one reservoir for collecting carbohydrate-containing and/or oil-containing liquid derived from the waste material, the reservoir being in operative communication with at least one component of the system which handles waste material and/or a material derived therefrom. In some embodiments, the reservoir is in communication with at least one shredder adapted for conveying liquid from waste material and/or a sorted material derived therefrom undergoing shredding to the reservoir (e.g., being adapted for draining liquid).

In some embodiments of any of the embodiments pertaining to a system described herein, the reservoir is configured for separating oils from at least a portion of the liquid (e.g., as described herein).

In some embodiments of any of the embodiments pertaining to a system described herein, the reservoir is configured for separating carbohydrate(s) from at least a portion of the liquid (e.g., as described herein).

In some embodiments of any of the embodiments pertaining to a system described herein, the reservoir is configured as a fermentor and/or reactor suitable for

processing the carbohydrate(s) by fermentation, heating, and/or reaction with a reagent (e.g., as described herein).

FIG. 3 is a schematic illustration of a system **130** for processing waste material, according to some embodiments of the present invention. System **130** optionally and preferably comprises one or more separating chambers **132** for removing at least a portion of inorganic materials in the waste material and an extruder system, such as, but not limited to, extruder system **110**.

In some embodiments, one or more of the separating chambers removes material (e.g., inorganic materials, thermoset polymers, PET, PTFE, PVC) which sinks in the liquid and in some embodiments, one or more of the separating chambers removes material which floats on the liquid. Also contemplated are embodiments in which one or more of the separating chambers removes material which floats on the liquid and/or material which sinks in the liquid, wherein the configuration of the respective separating chamber is being controllable and reversible. The removed material may be transferred, for example, to a bin (not shown) adapted for receiving removed materials.

In some embodiments, system **130** comprises two or more separating chambers, a first separating chamber for separating materials according to specific gravity as described herein, to thereby obtain a partially sorted material, and at least one additional separating chamber for subjecting the partially sorted material to at least one additional cycle of separating materials according to specific gravity (e.g., as described herein).

Different separators in system **130** may contain the same liquid or different liquids. The liquid of each separating chamber is preferably selected such that a portion of inputted waste material or partially sorted material sinks therein.

Separating chamber **132** preferably provides the feedstock to extruder system either directly or, as illustrated in FIG. 3, via a conduit **134**, which is optionally and preferably provided with a controllable valve **134'** for controlling the flow from chamber **132** to extruder system **110**. The principles according to which the feedstock is formed from the waste material are described in greater detail below. In the illustration of FIG. 3, chamber **132** provides the feedstock to conduit **134** (or directly to extruder system **110**) from the upper part of chamber **132**. This embodiment is particularly useful when the inorganic material sinks in the liquid. When the removed

inorganic material floats on the liquid, it may be preferred to constitute chamber **132** to provide the feedstock from the lower part of chamber **132**.

In some embodiments, system **130** comprises a shredder **138** for shredding the material before entering the separation chamber **132** or after exiting separation chamber **132**. While FIG. 3 illustrates a configuration in which shredder **138** feeds a shredded waste material to chamber **132** (via a conduit **140**, which is optionally and preferably provided with a controllable valve **140'** for controlling the outflow from shredder **138**), this need not necessarily be the case, since in some embodiments shredder **138** is positioned between chamber **132** and extruder system **110**, so that shredder **138** receives the feedstock from chamber **132**, shreds the feedstock and provides a shredded feedstock to extruder system **110** (e.g., conduit **140** and valve **140'** which in this embodiment connect shredder **138** with extruder system **110**). Further, the present embodiments also contemplate configurations in which system **130** comprises more than one shredder, for example, one shredder before chamber **132** and one shredder between chamber **132** and extruder system **110**.

Thus, the system optionally and preferably is adapted for processing a shredded feedstock (e.g., as described herein). Shredding of feedstock may be performed by providing the feedstock and then shredding it, and/or by shredding one or more materials (e.g., a sorted material and additional material(s) described herein) prior to the materials being combined to form the feedstock.

In some embodiments, the system comprises two or more shredders configured to operate in tandem, so as to facilitate provision of a continuous supply of shredded feedstock to extruder system **110**.

In some embodiments, system **130** mixes a sorted material (e.g., a sorted material described herein) and or a processed material produced by the system an additional material (e.g., as described herein). In some embodiments, system **130** directly mixes the sorted material with an additional material, to thereby provide the feedstock. In some embodiments, system **130** indirectly mixes sorted material with an additional material, by mixing waste material with an additional material prior to sorting the waste material, such that the obtained sorted material comprises the additional material.

Optionally, the sorted material can be mixed with the additional material (e.g., prior to the transfer to extruder system **110**) using any device suitable for mixing such materials.

Alternatively or additionally, extruder system **110** mixes the sorted material with
5 an additional material after the materials are received by system **110**, such that the feedstock is provided within the barrel of the extruder system.

The various materials employed by system **130** can be provided in separate reservoirs **142**. Six reservoirs **142a-f** are shown in FIG. 3 but any number of reservoirs is contemplated, including a single reservoir. Each reservoir optionally and preferably
10 contains a different type of material. For example, the system may comprise a first reservoir for containing a sorted material (e.g., as described herein) and one or more reservoirs for containing one or more additional materials as described herein and/or a different sorted material than is contained in the aforementioned first reservoir (e.g., sorted material derived from a different source of waste material and/or sorted material
15 provided by a different sorting process).

Each of the reservoirs is arranged to receive material from shredder **138** or chamber **132** or extruder system **110**, and/or to feed material into shredder **138** or chamber **132** or extruder system **110**. Material flow from and/or to the reservoirs is by means of one or more conduits that are schematically illustrated at **144a-144f**. Other
20 connections are also contemplated. One or more of the conduits is optionally and preferably provided with a controllable valve for controlling the inflow and/or outflow from the respective reservoir. These controllable valves are shown at **144a'-144f'**.

In some embodiments, at least one of reservoirs **142** contains carbohydrate(s) obtained from a liquid derived from the waste material (e.g., as described herein). Such
25 a reservoir is optionally configured to receive the carbohydrate(s) obtained as described herein.

Controller **123** can also be employed by system **130**. The controller is optionally and preferably configured to control the various valves so as to select the proportions of material from the different reservoirs that are used for preparing the
30 feedstock. Alternatively, system **130** can include more than one controller, wherein one controller (e.g., controller **123**) controls the controllable components of extruder system **110**, and another controller controls the material proportions. The controller can also

include a circuit having monitoring capabilities, for example, for monitoring a composition and/or specific gravity of the liquid the separating chamber, for example, by receiving signals from a sensor or a camera **137** installed in or in proximity to separating chamber **132**. In some embodiments, the controller adjusts a composition and/or specific gravity of the liquid, for example, for maintaining a specific gravity at a predetermined value (e.g., within a predetermined range). In some embodiments, the controller controls the entry of water and/or additional substance such as a solute (e.g., a salt described herein) into the separating chamber, to thereby adjust the composition and/or specific gravity of the liquid.

10 System **130** optionally and preferably produces a processed material comprising a polymeric material (e.g., a processed material described herein), optionally a thermoplastic polymeric material such as described herein.

 According to another aspect of embodiments of the invention there is provided a system for processing a waste material (e.g., a waste material described herein), to form a non-particulate processed material (e.g., as described herein), wherein a feedstock (e.g., as described herein) derived from a waste material is subjected to mixing and heating without being dried (e.g., according to a method described herein). The feedstock may optionally have a relatively high water content (e.g., as described herein).

20 The system for processing a waste material incorporates a system for sorting a waste material, comprising one or more separators, as described herein. In some embodiments of any of the embodiments pertaining to a system described herein, the system for sorting a waste material is configured for removing at least a portion of inorganic materials in the waste material, such that the obtained sorted material contains at least 90 weight percents of an organic material (e.g., as described herein).

 The system for processing a waste material is configured for providing a feedstock comprising sorted material obtained from the system for sorting a waste material (e.g., a feedstock described herein), the feedstock having a water content of at least 15 weight percents (e.g., a water content described herein).

30 In some embodiments of any of the embodiments pertaining to a system described herein, the system is adapted for removing some materials (e.g., inorganic materials, thermoset polymers, PET, PTFE, PVC) from waste material (e.g., as

described herein), such that the feedstock has a reduced content of such materials (relative to the waste material).

In some embodiments of any of the embodiments pertaining to a system described herein, the system is configured for contacting the feedstock and/or a material
5 incorporated into the feedstock (e.g., a sorted material and/or a waste material prior to sorting) with an acidic substance.

The system for processing a waste material further comprises an apparatus for subjecting the feedstock to mixing via shear forces, and to heating.

FIG. 4 illustrates an exemplary apparatus **200** for subjecting the feedstock to
10 mixing via shear forces (e.g., as described herein), as well as optional components of a system for processing a waste material which are associated with the apparatus, according to some embodiments of the invention. Apparatus **200** comprises an inlet **210** and an outlet **260**, as well as a first mixing zone **220** and a second mixing zone **240**, and optionally a third mixing zone **290**, each mixing zone being independently adapted
15 for subjecting the feedstock to heating. Apparatus **200** further comprises a first vent **230** and a second vent **250**, each being adapted for removing gases released during mixing and heating (e.g., as described herein) from apparatus **200**. Apparatus **200** is configured for subjecting the feedstock entering inlet **210** to mixing in first mixing zone **220**, removal of gases released in first mixing zone **220** via first vent **230**, and
20 subsequently subjecting the feedstock to mixing in second mixing zone **240** and removal of gases released in second mixing zone **240** via second vent **250**. Apparatus **200** is optionally further configured for subjecting the feedstock to mixing in third mixing zone **290**. First mixing zone **220** is adapted for mixing wet feedstock (e.g., waste material having a water content described herein), whereas second mixing zone
25 **240** is adapted for mixing semi-wet feedstock (e.g. feedstock partially dried by heating in mixing zone **220**), and optional third mixing zone **290** is adapted for mixing dry feedstock (e.g. feedstock dried by heating in mixing zone **240**). A processed material then exits outlet **260**.

In some embodiments, the system further comprises optional apparatus **295**,
30 which is configured for molding processed material received from second mixing zone **240** or third mixing zone **290**. Apparatus **295** may optionally be configured as a component of apparatus **200** (e.g., as depicted in FIG. 4), or alternatively, as a separate

apparatus, for example a separate apparatus which is in communication with apparatus **200**. Optionally, apparatus **295** is configured for extrusion molding, and comprises a die suitable for extrusion molding in communication with mixing zone **240** or **290**.

In some embodiments, mixing is effected by at least one optional screw and/or blade **270** (e.g., as described herein). The at least one screw and/or blade optionally extends through mixing zones **220** and **240** (and optionally also mixing zone **290**), so as to be capable of effecting mixing in both zones. When more than a single screw and/or blade is used, the screws and/or blades may be co-rotated or counter-rotated. In some embodiments, mixing zone **220** comprises counter-rotated screws and/or blades. In some embodiments, mixing zone **240** comprises a single screw and/or blade (e.g., configured as an extruder). Screws and/or blades may be intermeshing, or non-intermeshing. In some embodiments, the direction of extrusion through mixing zone **220** is approximately perpendicular to the direction of extrusion through mixing zone **240**, and/or the direction of extrusion through mixing zone **240** is approximately perpendicular to the direction of extrusion through mixing zone **290**.

Mixing zones **220**, **240** and **290** are preferably adapted for subjecting feedstock to a first cycle, a second cycle, and a third cycle, respectively, of heating and mixing, as described herein. Mixing zones **220**, **240** and **290** are each independently adapted for heating the feedstock at a temperature described herein, optionally a temperature in a range of from 90 °C to 230 °C, optionally from 90 °C to 180 °C, and optionally from 140 °C to 180 °C. Optionally, the apparatus in general, and the mixing zones in particular, are adapted for effecting mixing and heating (e.g., mixing and heating as described herein) simultaneously.

In some embodiments, apparatus **200** is configured such that material therein is passed through one or more optional screens (e.g., one or more screens as described herein). The one or more screens are optionally configured so as to be readily removable from the apparatus, for example, to facilitate cleaning of the screen(s). The screen(s) may optionally be located at any portion of the apparatus, including, for example, at inlet **210**, at outlet **260**, in first mixing zone **220**, second mixing zone **240**, third mixing zone **290**, first vent **230** and/or second vent **250**. In some embodiments, at least one screen is positioned such that material passes through the screen(s) shortly before entering apparatus **295**, for example, positioned at the entry into apparatus **295**

(e.g., when apparatus **295** is configured as a component of apparatus **200**) or at outlet **260** (e.g., when apparatus **295** is configured as a separate apparatus, in communication with apparatus **200**).

The system optionally comprises at least one temperature control element **280**
5 adapted for heating the feedstock as described herein in mixing zones **220** and **240** (and optionally also mixing zone **290**). Temperature control element **280** comprises a heating element (e.g., an electric heater) for heating the waste material, and optionally also a cooling element (e.g., comprising a cooling fluid) for avoiding excessive temperatures. A heating element and cooling element may be joined in a single module, or may be
10 present in separate modules. The system may optionally comprise one or more temperature control elements adapted for effecting heating (and optionally also cooling) in both mixing zones **220** and **240**, and optionally also mixing zone **290** (as depicted in FIG. 4). Alternatively or additionally, the system comprises separate temperature control elements for each of mixing zones **220** and **240** (and optionally also **290**).
15 Alternatively, the system comprises one or more temperature control elements adapted for effecting heating (and optionally also cooling) in one mixing zone (e.g., mixing zone **220**) directly, wherein heating of the other mixing zone (e.g., mixing zones **240** and/or **290**) is effected by heat transfer from the directly heated mixing zone.

In some embodiments, at least a portion of temperature control element **280** is in
20 screw and/or blade **270**. Optionally, temperature control element **280** comprises a heated (and/or cooled) fluid flowing through at least a portion of the length of screw and/or blade **270**, for effecting heating (and/or cooling), and optionally further comprises a mechanism (which may be inside or outside in screw and/or blade **270**) for heating (and/or cooling) the fluid.

25 In some embodiments, the apparatus further comprises a zone configured for intake of the feedstock, being in communication with first mixing zone **220** (e.g., via inlet **210**).

In some embodiments, the system further comprises a module configured to allow continuous feeding of feedstock into apparatus **200** (e.g., via inlet **210**), such that
30 little or no air enters apparatus **200** with the feedstock. Such a module may optionally comprise a conical extruder and/or an internal mixer. The module optionally comprises

a feeding controller configured to monitor (e.g., by weighing) and control a rate of feeding of feedstock into apparatus **200**.

In some embodiments, the apparatus further comprises one or more heating controllers for maintaining a desired temperature (e.g., a temperature described herein) in at least a portion of the apparatus (e.g., in first mixing zone **220** and/or in second mixing zone **240**).

In some embodiments, the apparatus further comprises at least one sensor, for determining a water content of the feedstock at one or more locations in the apparatus. By monitoring water content, the sensor(s) may allow for control over the water content of the processed material produced by the system, such that the processed material will have a desired water content (e.g., a water content described herein), for example, less than 1 weight percent.

In some embodiments, apparatus **200** is an extruder, as described herein.

In some embodiments, the system is adapted for processing a shredded feedstock (e.g., as described herein).

Thus, in some embodiments, the system further comprises a shredder configured for shredding feedstock prior to subjecting to mixing (e.g., prior to intake via inlet **210**). In some embodiments, the system is configured such that feedstock shredded by the shredder passes into the abovementioned module configured to allow continuous feeding of feedstock into apparatus **200**. Shredding of feedstock may be performed by providing the feedstock and then shredding it, and/or by shredding one or more materials (e.g., a sorted material and additional material(s) described herein) prior to the materials being combined to form the feedstock.

In some embodiments, the system comprises at least two shredders configured to operate in tandem, so as to facilitate provision of a continuous supply of shredded feedstock to inlet **210** (optionally via the abovementioned module configured to allow continuous feeding of feedstock into apparatus **200**).

In some embodiments, the system is configured for mixing a sorted material (e.g., a sorted material described herein) and or a processed material produced by the system an additional material (e.g., as described herein).

In some embodiments, the system is configured for directly mixing sorted material with an additional material, to thereby provide the feedstock. In some

embodiments, the system is configured for indirectly mixing sorted material with an additional material, by mixing waste material with an additional material prior to sorting the waste material, such that the obtained sorted material comprises the additional material.

5 Optionally, the system further comprises an apparatus for mixing the sorted material with the additional material prior to subjecting to mixing in first mixing zone **220** (e.g., prior to intake via inlet **210**). Any device used in the art for mixing such materials may be included in the system.

10 Alternatively or additionally, the system is configured such that the sorted material is mixed with an additional material in first mixing zone **220**, such that the feedstock is provided (in its final form) in first mixing zone **220** concomitantly with performance of the mixing in first mixing zone **220**.

15 Without being bound by any particular theory, it is believed that the inclusion of vents **230** and **250** allows for release of excess gases, thereby avoiding potentially damaging increases of pressure inside the apparatus, while maintaining a sufficiently closed system which results in a suitable environment (e.g., low oxygen concentration, high temperature) which facilitates the desired chemical reactions. In addition, it is to be appreciated that release of gases removes heat, and may be used to control the temperature in the mixing zones.

20 It is to be understood, that additional vents and/or additional mixing zones (e.g., between the mixing zones **220** and **240**) may be included in the system.

25 In some embodiments, the length of the apparatus, as measured from mixing zone **220** to vent **250**, is at least 6 meters, optionally at least 7 meters, optionally at least 8 meters, optionally at least 9 meters, optionally at least 10 meters, optionally at least 11 meters, optionally at least 12 meters, and optionally at least 15 meters. In exemplary embodiments, the length is about 11 meters.

30 Without being bound by any particular theory, it is believed that the aforementioned lengths allow for a longer residence time of the feedstock in the apparatus, which enhances the chemical reactions which occur therein, thereby improving the physicochemical properties of the obtained processed material.

 In some embodiments of any of the embodiments pertaining to an apparatus described herein, the residence time of feedstock in the apparatus is at least 5 minutes.

In some embodiments, the residence time of feedstock in the apparatus is at least 10 minutes. In some embodiments, the residence time of feedstock in the apparatus is at least 15 minutes. In some embodiments, the residence time of feedstock in the apparatus is at least 20 minutes. In some embodiments, the residence time of feedstock in the apparatus is at least 30 minutes. In some embodiments, the residence time of feedstock in the apparatus is at least 40 minutes. In some embodiments, the residence time of feedstock in the apparatus is at least 60 minutes.

It is to be noted that the residence time as described herein corresponds to the duration of the feedstock mixing stage in a method as described herein for processing a waste material.

In some embodiments of any of the embodiments pertaining to a system described herein, the system further comprises a plurality of reservoirs, each reservoir being for containing a different type of material. For example, the system may comprise a first reservoir for containing a sorted material (e.g., as described herein) and one or more reservoirs for containing one or more additional materials described herein and/or a different sorted material than is contained in the aforementioned first reservoir (e.g., sorted material derived from a different source of waste material and/or sorted material provided by a different sorting process).

The reservoirs are optionally in communication with an apparatus for mixing sorted material with the additional material (e.g., as described herein) and/or for mixing and heating feedstock (e.g., first mixing zone **220** in apparatus **200**), so as to allow thorough mixing of the materials from the different reservoirs, to thereby form the feedstock.

In some embodiments of any of the embodiments pertaining to a system described herein, at least one reservoir is for containing carbohydrate(s) obtained from a liquid derived from the waste material (e.g., as described herein). Such a reservoir is optionally configured to receive the carbohydrate(s) from an apparatus configured for collecting the carbohydrate(s) obtained from a waste material-derived liquid (e.g., as described herein) obtained from one or more components of the system, such as one or more shredders and/or one or more separators (e.g., as described herein).

Thus, the system optionally further comprises an apparatus configured for collecting the carbohydrate(s) from a liquid obtained from one or more components of

the system, such as one or more shredders and/or one or more separators (e.g., as described herein). Such components in communication with the apparatus for collecting liquid may optionally be configured for conveying waste material-derived liquid to the apparatus.

5 The system is optionally configured so as to allow control over the proportions of material from the different reservoirs, so as to thereby provide control over the composition of the feedstock subjected to heating and mixing (e.g., in apparatus **200**).

 As exemplified in the Examples section, the system described herein is suitable for producing a processed material comprising a polymeric material (e.g., a processed
10 material described herein), optionally a thermoplastic polymeric material such as described herein.

 As used herein the term “about” refers to $\pm 10\%$.

 The terms "comprises", "comprising", "includes", "including", “having” and their conjugates mean "including but not limited to".

15 The term "consisting essentially of" means that the composition, method or structure may include additional ingredients, steps and/or parts, but only if the additional ingredients, steps and/or parts do not materially alter the basic and novel characteristics of the claimed composition, method or structure.

 The word “exemplary” is used herein to mean “serving as an example, instance or
20 illustration”. Any embodiment described as “exemplary” is not necessarily to be construed as preferred or advantageous over other embodiments and/or to exclude the incorporation of features from other embodiments.

 The word “optionally” is used herein to mean “is provided in some embodiments and not provided in other embodiments”. Any particular embodiment of the invention
25 may include a plurality of “optional” features unless such features conflict.

 As used herein, the singular form "a", "an" and "the" include plural references unless the context clearly dictates otherwise. For example, the term "a compound" or "at least one compound" may include a plurality of compounds, including mixtures thereof.

 Throughout this application, various embodiments of this invention may be
30 presented in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the invention. Accordingly, the description of a range should

be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as
5 individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

Whenever a numerical range is indicated herein, it is meant to include any cited numeral (fractional or integral) within the indicated range. The phrases “ranging/ranges between” a first indicate number and a second indicate number and “ranging/ranges
10 from” a first indicate number “to” a second indicate number are used herein interchangeably and are meant to include the first and second indicated numbers and all the fractional and integral numerals therebetween.

As used herein the term "method" refers to manners, means, techniques and procedures for accomplishing a given task including, but not limited to, those manners,
15 means, techniques and procedures either known to, or readily developed from known manners, means, techniques and procedures by practitioners of the chemical arts.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for
20 brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

25 Various embodiments and aspects of the present invention as delineated hereinabove and as claimed in the claims section below find experimental support in the following examples.

EXAMPLES

30 Reference is now made to the following examples, which together with the above descriptions illustrate some embodiments of the invention in a non-limiting fashion.

EXAMPLE 1***General procedure for separating waste material***

A general procedure for separating waste material according to some embodiments of the present invention is shown in FIG. 1.

5 In some embodiments, the procedure is performed using a system such as described and exemplified in FIG. 11 and/or in FIG. 12.

Waste material **10** is provided, optionally “wet” waste material, i.e., waste material which has not been subjected to drying, and optionally wet substantially unsorted waste material (SUW). The waste material is preferably domestic waste material, e.g., collected from private households. Optionally, the waste material has
10 been subjected to preliminary processing procedures (e.g., at a waste disposal facility), such as crushing (e.g., by a hammer mill), and/or removal of magnetic materials.

Waste material **10** is subjected to separation according to specific gravity **20** (by contacting the waste material **10** with a liquid), resulting in separation of waste material
15 **10** into a low-specific gravity material **12** and a high-specific gravity material **14**. Low-specific gravity material **12** (and optionally high-specific gravity material **14**) is subjected to shredding **25**, resulting in a shredded material, which may optionally be subjected to one or more additional cycles of separation of waste material **10** into a low-specific gravity material **12** and a high-specific gravity material **14**, and optionally
20 shredding the low-specific gravity material **12** and/or high-specific gravity material **14**.

The separated high-specific gravity material **14** may optionally be further sorted so as to extract useful and/or valuable materials such as metals (e.g., iron, gold) and silica and/or glass (e.g., for use as filler).

Additional cycles of separation **20** may be according to the same distinction
25 between low-specific gravity material and high-specific gravity material (e.g., using the same specific gravity of liquid used for separation) as in a previous cycle or a different distinction between low-specific gravity material and high-specific gravity material (e.g., using a different specific gravity of liquid used for separation).

Additional cycles of separation **20** and shredding **25** optionally comprise finer
30 shredding of material than in a previous cycle.

Optionally, the first cycle of separation **20** and shredding **25** comprises removing high-specific gravity inorganic materials which may interfere with shredding **25**, followed by at least one additional cycle of separation **20**.

5 Optionally, additional cycle of separation **20** is made more effective due to the previous shredding **25**, which facilitates, for example, removal of air pockets from the material and/or dismantling of waste material particles into their component materials.

Optionally, shredding **25** is performed in such a manner as to remove liquid (e.g. liquid absorbed during separation **20**) from the sorted material being shredded, for example, by compression (e.g., using a screw press) and/or drainage of the material during shredding. Optionally, shredding **25** is performed in such a manner after each
10 cycle of separation **20**.

Additional materials (e.g., as described herein) may optionally be added at any stage, during one or more cycles described herein, for example, to waste material **10**, to low-specific gravity material **12** and/or to high-specific gravity material **14** prior to
15 and/or subsequent to shredding **25**.

Sorted material obtained according to this general procedure may optionally be subjected to a procedure for processing a feedstock by mixing and heating, e.g., the procedure described in Example 2.

20

EXAMPLE 2

General procedure for processing a feedstock derived from waste material by mixing and heating

A general procedure for processing a feedstock derived from waste material according to some embodiments of the present invention is shown in FIG. 2.

25

In some embodiments, the procedure is performed in a system such as described and exemplified in FIG. 4 and/or in FIG. 12.

Sorted material **70** is provided by separating waste material according to the general procedure described in Example 1, so as to remove at least a portion of inorganic material from the waste material.

30

The sorted material is optionally combined with an additional material **80** to form feedstock **90**. Alternatively, feedstock **90** consists essentially of sorted material **70**.

Feedstock **90** comprising the (optionally shredded) sorted material, optionally in combination with an additional material, is subjected to mixing via shear forces **30** and heating **32**. In some embodiments, mixing **30** and heating **32** are effected in a first zone **220** of apparatus **200** shown in FIG. 4. Following mixing **30** and heating **32** is removing **40** of gases released during said mixing and heating. Removing **40** of the gases is optionally effected by pumping gases out of the waste material. In some embodiments, removing of gases **40** is effected in vent **230** of apparatus **200** shown in FIG. 4. 5

Mixing **30** and heating **32** and removing **40** result in processed material **50**. Processed material **50** is then optionally subjected to one or more additional cycle **35** of steps **30**, **32** and **40**. Additional cycle **35** may comprise the same conditions as steps **30** and/or **32** or different conditions (e.g., different temperature and or level of shear forces). Processed material **50** may be subjected to molding **60**. In some embodiments, molding **60** comprises pelletizing. 10

In some embodiments, a second cycle of mixing **30** and heating **32** are effected in a second zone **240** of apparatus **200** shown in FIG. 4. In some embodiments, a second removing of gases **40** is thereafter effected in vent **250** of apparatus **200** shown in FIG. 4. 15

The processed material then optionally undergoes quality control and/or packaging. In some embodiments, quality control is performed on processed material **50** immediately upon completing steps **30**, **32** and **40** (e.g., while material is still hot). Such quality control is optionally utilized to regulate any of the previous steps. 20

EXAMPLE 3

Composition of processed material obtained by exemplary procedures 25

Waste material was separated in an aqueous salt solution comprising about 10 weight percents NaCl, according to the procedures described in Example 1. The separated low density portion of the waste material was then used as a feedstock for processing by mixing and heating according to the procedures described in Example 2. A representative sample of the obtained processed material (in its extruded form) is depicted in FIGs. 5A and 5B. 30

For comparison, waste material from the same source was also processed by mixing and heating according to the procedures described in Example 2, without a prior separation process.

When using the feedstock produced via separation of waste material, during the heating and mixing, the heated material passed through 3 mm screens which were intended to block contents which do not melt or soften. In contrast, when using (non-separated) waste material, the screens could not be used because they immediately became clogged by solid, inorganic materials.

Similarly, processed material obtained using the feedstock produced via separation of waste material could be readily pelletized, whereas the processed (non-separated) waste material clogged the pelletizer.

The density of the processed material obtained using the abovementioned feedstock was 1.07 grams/cm³, whereas the density of the processed (non-separated) waste material was 1.29 grams/cm³. This result confirms that the separation results in a substantial reduction in the density of the processed material derived from waste material.

The mineral composition of the samples was then analyzed by extracting 10 grams of each sample in 500 ml of boiling water, and performing an elemental analysis on the water by inductively coupled plasma (ICP) mass spectroscopy. The concentrations of elements for which at least 1 mg/liter was detected (in at least one sample), as well as toxic metals (arsenic, barium, cadmium, cobalt, chromium, mercury, nickel, lead, antimony, selenium), are presented in Table 1.

Table 1: Concentration (mg/liter) of elements in extract of processed material derived from waste material, with or without prior separation of waste material (N.D. = not detected; underlining indicates relatively high change in concentration; italics indicate greatest changes in concentration)

Element	Without separation	With separation (in 10 % NaCl solution)
Boron	2.0	2.4
Calcium	<u>45.4</u>	<u>25.0</u>
Potassium	<u>48.4</u>	<u>16.7</u>

Magnesium	<u>0.8</u>	<u>1.6</u>
Sodium	<u>82.6</u>	<u>462</u>
Sulfur	<u>20.9</u>	<u>9.2</u>
Silicon	<u>4.8</u>	<u>17.4</u>
Arsenic	N.D.	N.D.
Barium	0.011	0.024
Cadmium	N.D.	N.D.
Cobalt	0.010	0.004
Chromium	0.017	0.012
Mercury	N.D.	N.D.
Nickel	0.15	0.03
Lead	0.02	0.01
Antimony	0.06	0.04
Selenium	N.D.	N.D.

As shown in Table 1, separating the waste material in an aqueous salt (NaCl) solution resulted in a five-fold increase in the concentration of sodium in the obtained processed material. This indicates that some salt is incorporated into the sorted material
5 obtained using the salt solution, thereby affecting the composition of the final product.

As further shown therein, separating the waste material in the aqueous salt solution resulted in a decrease in the concentrations of common ions such as calcium and potassium (but not magnesium), which may reflect exchange of cations in the waste material by sodium and/or extraction of water-soluble ions by the aqueous salt solution.

10 The small increase in magnesium concentration may be due to a presence of magnesium in sea salt.

As further shown therein, separating the waste material in the aqueous salt solution resulted in a decrease in the concentrations of each of the detectable toxic metals, except for barium (possibly due to the presence of barium in sea water). This
15 indicates that the separation process reduces toxicity of processed material.

In order to further characterize the elemental composition of the processed material obtained via separation of waste material, elemental analysis was performed by

CHNS (carbon, hydrogen, nitrogen, sulfur) flash combustion analysis (using a Thermo Flash EA-1112 elemental analyzer) and by X-ray photoelectron spectroscopy (XPS).

According to the CHNS elemental analysis, the weight percentage of carbon in the processed material obtained via separation of waste material was $69.5\pm 0.3\%$, the weight percentage of hydrogen in the processed material was $10.8\pm 0.1\%$, the weight percentage of nitrogen in the processed material was $0.38\pm 0.01\%$, and the weight percentage of sulfur in the processed material was less than 0.1% .

The weight percentages of elements according to the XPS elemental analysis are presented in Table 2 (elemental percentages exclude hydrogen and helium, which are not detected by this method).

Table 2: Elemental composition of exemplary processed material

Element	Weight percentage	Atom percentage
Carbon	64.93	73.95
Oxygen	25.81	22.07
Sodium	1.56	0.93
Magnesium	0.15	0.08
Aluminum	0.61	0.31
Silicon	1.67	0.81
Phosphorus	0.07	0.03
Sulfur	0.06	0.03
Chlorine	2.40	0.92
Potassium	0.04	0.02
Calcium	1.62	0.55
Titanium	0.74	0.21
Iron	0.35	0.09

Taken together, the above elemental analyses indicate that processed material obtained via separation of waste material consists primarily of carbon (e.g., at least about 60 weight percents), oxygen (e.g., at least about 20 weight percents), hydrogen (e.g., about 10 weight percents) and a small amount of nitrogen (e.g., about 0.4 weight percent), with much of the balance being sodium and chlorine in approximately

equimolar amounts (e.g., each representing about 0.9 % of the total amount of atoms). Carbon, oxygen and hydrogen alone represent over 90 percent of the total amount of atoms in the material. The significant amount of sodium and chlorine is presumably due to the salt in the solution used for separating.

5 The composition was further analyzed using calorimetry. 6.67 mg of the processed separated waste material was analyzed from 25 to 300 °C at a rate of 10 °C per minute.

 As shown in FIG. 6, the processed material obtained via separation of waste material was characterized by a phase transition at about 109 °C which was associated
10 with a heat of transition of about 32 joules per gram, and by a phase transition at about 153 °C which was associated with a heat of transition of about 20 joules per gram.

 These results suggest the presence of polyethylene (associated with the melting point of about 109 °C) and polypropylene (associated with the melting point of about 153 °C), both of which are common in waste material, and which have a relatively low
15 specific gravity.

 The processed material obtained via separation of waste material was compared to the processed (non-separated) waste material by Fourier transform infrared (FTIR) spectroscopy. Polyethylene (20 %) was added to each sample.

 As shown in FIG. 7, both samples exhibited similar IR peaks at about 2800-
20 3000 cm^{-1} (associated with carbon-hydrogen bonds), but the processed material obtained via separation of waste material exhibits a different and less complex spectrum in the “fingerprint region” of about 600 to 1800 cm^{-1} , as compared to the processed (non-separated) waste material. The correlation of the spectra was 0.97 over the range of 600-4000 cm^{-1} , but only 0.77 over the range of 600-2724 cm^{-1} .

25 In addition, the processed material obtained via separation of waste material met European Union REACH regulation standards.

 This result indicates that separation of the waste material results in a processed material that has a more hydrocarbon-like nature, presumably due to the removal of materials which are denser than hydrocarbons and similar materials.

EXAMPLE 4***Separation of waste material using 15 % salt solution***

Waste material was separated in an aqueous salt solution comprising about 15 weight percents NaCl, according to the procedures described in Examples 1 and 3, to obtain a feedstock. The 15 % salt solution resulted in incorporation in the feedstock of a higher percentage of relatively dense organic polymers, typically characterized by a relatively high ratio of heteroatoms (e.g., poly(ethylene terephthalate), characterized by C₁₀H₈O₄ units), in the sorted material.

The feedstock was processed by mixing and heating according to the procedures described in Examples 2 and 3, to obtain a processed material which was moderately denser and/or richer in heteroatoms (e.g., oxygen) than the processed material obtained using a 10 % salt solution, as described in Example 3.

The physical properties of the processed material were analyzed by measuring tensile strength, tensile modulus, and notched impact strength (according to ISO 179eA standards), and compared to the corresponding properties of the common polymers low-density polyethylene (LDPE), high-density polyethylene (HDPE) and polypropylene (PP). The results are presented in Table 3.

Table 3: Physical properties of exemplary processed material, polyethylene and polypropylene

	Processed material prepared by separating waste material	Low-density polyethylene (LDPE)	High-density polyethylene (HDPE)	Polypropylene (PP)
Tensile strength (MPa)	12	11	27	35
Tensile modulus (MPa)	375	150	1100	1650
Tensile strength (%)	85	95	9	9
notched impact strength - ISO 179eA (kJ/m ²)	52.5	60	4	2.5

The melt-flow index of the processed material was measured according to ISO 1133 standards at a temperature of 190 °C, and found to be 3.6 grams per 10 minutes.

In contrast, the melt flow index of processed material prepared by heating and mixing non-separated waste material could not be measured, as the material did not
5 flow at 190 °C.

These results indicate that the separation of waste material for preparing a feedstock, as described herein, improves the flowability of the obtained processed material, and that the physical properties of the obtained processed material are similar to those of polyethylene.

10

EXAMPLE 5

Separation of waste material using 20 % salt solution

Waste material was separated in an aqueous salt solution comprising about 20 weight percents NaCl, according to the procedures described in Examples 1 and 3, to obtain a feedstock. The 20 % salt solution resulted in incorporation in the feedstock of
15 a higher percentage of relatively dense organic polymers, typically characterized by a relatively high ratio of heteroatoms (e.g., poly(ethylene terephthalate), characterized by C₁₀H₈O₄ units), in the sorted material, as compared to the feedstocks described in Examples 3 and 4.

The feedstock was processed by mixing and heating according to the procedures
20 described in Examples 2 and 3, to obtain a processed material which was moderately denser and/or richer in heteroatoms (e.g., oxygen) than the processed material obtained using a 10 % salt solution, as described in Example 3, or the processed material obtained using a 15 % salt solution, as described in Example 4.

25

EXAMPLE 6

Processed material derived from waste material mixed with polypropylene copolymer

Processed material prepared as described in Example 5 was combined with polypropylene copolymer at a weight ratio of 30:70 (processed material: polypropylene copolymer) to form a plastic material. Five different batches of the plastic material
30 were prepared, and their physical properties were analyzed by measuring density, tensile strength at yield, tensile modulus, elongation at yield, elongation at break and

Izod impact strength (notched and unnotched samples). The results are presented in Table 4 below.

As shown in Table 4, batch-to-batch variations were relatively small, indicating that the product obtained by the methodology described herein is reproducible.

5 In addition, the obtained impact strengths were higher than those of similar plastic materials prepared using processed material prepared by heating and mixing non-separated waste material (data not shown).

Table 4: Physical properties of mixtures of exemplary processed material with polypropylene copolymer

10

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5	Average \pm standard deviation
Density (g/cm ³)	0.9461	0.9031	0.9281	0.9219	0.9289	0.9256 \pm 0.0155
Tensile strength at yield (MPa)	19.4	21.1	19.7	20.7	19.4	20.1 \pm 0.8
Tensile modulus (MPa)	1158	1215	1110	1194	1100	1155 \pm 50
Elongation at yield (%)	5	5	6	5	6	5.4 \pm 0.5
Elongation at break (%)	11	10	14	12	13	12 \pm 1.6
Izod impact strength - notched (J/m)	72	65	71	75	75	72 \pm 4
Izod impact strength - unnotched (J/m)	475	521	526	525	500	509 \pm 22

EXAMPLE 7

Spectroscopic analysis of processed material derived from waste material

15 A feedstock comprising waste material separated in an aqueous salt solution comprising about 20 weight percents NaCl was processed as described in Example 5. The feedstock was supplemented with polyethylene prior to processing of the feedstock.

The obtained processed material was examined by X-band electron paramagnetic resonance (EPR) and by nuclear magnetic resonance (NMR) spectroscopy.

As shown in FIG. 8, the main feature of the EPR spectrum was an anisotropic signal of a carbon radical, with $g_1 = 2.7$, $g_2 = 2.19$ and $g_3 = 1.7$, giving an isotropic g value of 2.20 (i.e., $(2.7+2.19+1.7)/3$).

This high g value, as compared to a classical carbon radical which is characterized by a g value of about 2.0, suggests an influence of a delocalized free electron surrounding the carbon radicals, thus generating a local magnetic field and increased g value.

As the carbon electrons are embedded in a polymeric structure and cannot rotate freely, an anisotropic EPR spectrum was obtained, with different g_1 , g_2 and g_3 values, representing interaction of each of the x , y and z components of the spin vector carbon with the external magnetic field.

In addition, the peak-to-peak width (ΔH_{pp}) observed in the EPR spectrum was very broad, about 1200 G (gauss), as compared to 1-20 G for a typical free carbon radical, and about 200 G for alkyl or allyl radicals in cellulose (for which the signal is broadened by hyperfine structure due to interaction of hydrogen atoms surrounding the carbon radical). The very broad signal suggests that the sample may contain several species of carbon radicals and/or that significant dipolar interactions between neighboring unpaired electrons are present.

The composition of the processed material was further characterized by solid-state NMR spectroscopy, performed using a Chemagnetics™ Infinity console (300 MHz proton frequency) with a Chemagnetics™ triply resonant variable temperature probe. ^{13}C spectra provided information regarding molecules in the processed material.

As shown in FIG. 9A, the NMR spectrum was dominated by peaks at 28, 31, 32.8 and 34 ppm (not shown) that are characteristic of polyethylene (PE) polymer, and which were far stronger than the peaks characteristic of cellulose. The peak at 32.8 ppm is typical of highly ordered arrangement of the aliphatic polymer chains in polyethylene, also called crystalline PE. The peak at 31 ppm is of semi-crystalline PE where chains are less tightly packed and some disorder in the polymer exists. A semi-quantitative analysis of the two peaks shows that about 2:1 exist between the crystalline and semi-crystalline polymer phases. Peaks at 21.8, 23.8, 26.5, 28.1 ppm and at 38.2 and 44 ppm

flank the main polymer lines. These lines and their ratios are indicative of the degree of branching in high-density polyethylene (HDPE). In typical commercial HDPE, the main polymer chain CH₂ groups appear at 27.1 -27.4 and 34-37.5 ppm and the branched chain CH₂ carbons at 26.6 ppm and CH₃ carbons at 19.9 ppm. Some shifts are possible compared to these values due to changes in measurement conditions and in material processing, therefore, the line at 21.8 is identified as branched CH₃, the 26.5 as branched CH₂ and main polymer lines at 28.1 and 38.2. The observed peak at 44 ppm was associated with C-OH or open chain ether group either in a polymer or in a smaller molecule. It is less than 1% of the total carbon content in the spectrum.

As shown in FIG. 9B, the NMR spectrum showed peaks at 65.8, 72, 75, 83.5, 89 and 105.5 ppm, which were identified as those of highly-crystalline cellulose, in accordance with Atalla et al. [*J Amer Chem Soc* 1980, 102:3249]. Peaks typical of lignin were not observed.

The lines at 94.6 and 96.5 ppm and the symmetric lines at -30.8 and -31.9 ppm are sidebands of the main PE carbon line due to sample spinning at 8000 Hz and have no chemical importance, as is the case with the small line observed at 160.1 ppm.

The weakness of NMR signal associated with lignocellulose as compared with polyolefin signal suggests that free radicals present in the processed material (as demonstrated by the EPR spectrum) selectively reduce the lignocellulose NMR signal, which indicates that free radicals are concentrated in lignocellulosic material in the processed material rather than in polyolefins in the processed material.

EXAMPLE 8

Effect of hypertonic solution on biomass in waste material

6 grams of fresh organic waste (carrot, cucumber, banana peels) was placed in samples of 60 ml fresh water or 60 ml of salt water with about 20 weight percents, and incubated at room temperature for 3 hours. Filtrates of each sample were then analyzed by ¹³C-NMR spectroscopy, performed as described in Example 7.

As shown in FIGs. 10A and 10B, the filtrate from the salt solution exhibited NMR signals in a range of from 60-100 ppm (FIG. 10A), typical of carbohydrates such as glucose and xylose, whereas no such signals were observed for the filtrate obtained from fresh water.

These results indicate that the use of hypertonic solutions to separate waste material breaks cell walls and facilitates release of carbohydrates.

EXAMPLE 9

System for separating waste materials according to specific gravity

An exemplary system for separating waste materials according to specific gravity according to some embodiments of the invention is shown in FIG. 11. The system is may optionally be incorporated within a larger system for sorting and/or processing waste material, as described herein.

The system comprises a container **300** which is at least partially filled with liquid **310**, and optionally a stirrer **350** (e.g., a paddle wheel) within container **300** or in communication with container **300**. Liquid **310** is selected to have a specific gravity suitable for separating waste material (e.g., in a range of from 1.00 to 2.50). Liquid **310** is optionally an aqueous solution. Container **300**, along with its associated devices (as described herein), is also referred to as a “separator”.

Container **300** is configured to allow waste material (optionally shredded waste material) to enter (as indicated by arrow **320**), and to allow some waste material at surface **315** of the liquid **310**, and optionally additional material in liquid **310** which does not sediment (e.g., is not at the bottom of container **300**), to exit container **300** via outlet **330** (as indicated by arrow **325**).

Optional conveyor **365** is located at or near surface **315**, and is configured to convey material at or near surface **315** of the liquid **310** out of container **300** via outlet **330**. For example, material floating at surface **315** comes into contact with conveyor **365**, allowing conveyor **365** to convey the material.

Optional conveyor **360** is configured to convey material at or near bottom of container **300** (e.g., sediment) out of container **300**. Conveyor **360** may optionally be configured to raise material above surface **315** before exiting container **300**.

Conveyor **365** and/or conveyor **360** optionally comprise teeth and/or grooves and/or the like (not depicted), configured for grabbing material, so as to facilitate conveying.

Outlet **330** is optionally configured to remove, optionally by gravity and/or centrifugal force, at least some liquid **310** which adheres to and/or is absorbed by sorted

materials exiting via outlet **330**, or otherwise leaks from container **300** into outlet **330**. Liquid **310** which is removed in outlet **330** may optionally be returned to container **300** via optional conduit **340**.

Liquid **310** is optionally a solution (optionally a salt solution) or a suspension,
5 comprising a solvent (optionally water) and an additional substance (e.g., a solute and/or a suspended substance).

The system is optionally configured to adjust a specific gravity of said liquid to a predetermined value (e.g., a value within a predetermined range).

Optional reservoir(s) **380** comprises water and/or additional substance, which
10 enter container **300** via conduit(s) **390** to replenish and/or adjust a composition and/or specific gravity of liquid **310**.

Optional monitor **370** is in communication with container **300**, and monitors a composition and/or specific gravity of liquid **310**. Monitor **370** is optionally configured to control entry of water and/or additional substance from reservoir(s) **380** into
15 container **300**, so as to control a composition and/or specific gravity of liquid **310**.

Optional container **395** receives sorted material exiting container **300** via outlet **330** (as indicated by arrow **325**), and is filled with a liquid (not shown) adapted for rinsing off at least some liquid **310** which adheres to and/or is absorbed by sorted materials exiting via outlet **330**.

20 In some embodiments, conveyor **315** extends into outlet **330**, and optionally into container **395**.

In some embodiments, an additional conveyor (not shown) conveys material through outlet **330** and/or container **395**.

Outlet **330** and/or container **395** is optionally configured for conveying sorted
25 material to an apparatus for shredding the sorted material (e.g., shredding to a finer particle size) and/or to an apparatus for heating and mixing a feedstock derived from waste material as described herein.

Container **300** and/or container **395** is optionally in communication with a filtration apparatus (not shown), optionally a reverse osmosis filtration apparatus,
30 adapted for filtering out solutes and/or small particles of material. In some embodiments, a filtration apparatus in communication with container **395** is adapted for filtering residual solute of liquid **310** out of the liquid in container **395**. In some

embodiments, a filtration apparatus in communication with container **300** is adapted for filtering small particles of material out of liquid **310** in container **300**.

In some embodiments, a system comprises a plurality (e.g., a pair) of containers **300** (e.g., a plurality of separators), configured for operating in parallel and/or in tandem, each configured as described herein (e.g., with conveyors **360** and **365**, stirrer **350** and outlet **330**), being in communication with a single container **395**. Such a configuration may allow for continuous operation of the system when one container **300** is not available for separating waste materials (e.g., due to maintenance and/or removal of waste materials therefrom) and/or for performing multiple cycles of separation (e.g., using liquids with different specific gravities).

EXAMPLE 10

System for separating and processing waste materials

An exemplary system for separating waste materials according to specific gravity and processing the waste materials according to some embodiments of the invention is shown in FIG. 12. The system may optionally be incorporated within a larger system for processing waste material, as described herein.

The system optionally comprises a waste reservoir **400** which is adapted for storing (e.g., for up to 24 hours or more) a large amount (e.g., about 25 tons) of waste materials without polluting (e.g., by odor pollution and/or leakage of liquids) the surrounding environment and/or for receiving transported waste materials (e.g., from a waste disposal vehicle). Optional waste reservoir **400** is configured for conveying waste material to a first separator **410** via optional conduit **402**, and optionally further configured for conveying gas released by the waste material therein to optional gas control system **496** via optional conduit **404** (e.g., a conveyor belt in communication with a bottom of reservoir **400**). Waste reservoir **400** is optionally configured for monitoring a weight of waste material therein.

Optional conduit **402** (e.g., a conveyor belt) is configured for conveying material comprising liquids without leakage (e.g., without leakage between slats of a conveyor belt). Conduit **402** is optionally configured for conveying waste material at a rate of at least 0.5-3 tons per hour.

First separator **410** contains an aqueous salt solution (e.g., at a volume of about 3-4 m³) and is configured for separating waste materials according to specific gravity as described herein (e.g., configured as a system described in Example 9), and for conveying partially sorted materials obtained by separation to first shredder **420** via conduit **412**. First separator **410** is optionally further configured for separating oils which float on a surface of the aqueous salt solution (e.g., by skimming) from the partially sorted materials and aqueous salt solution, first separator **410** optionally comprising a skimmer adapted for skimming oils (e.g., a weir skimmer, oleophilic skimmer and/or metallic skimmer described herein).

First separator **410** is adapted for partial separation (e.g., by compression and/or drainage) of liquid (composed to a large degree of the aqueous salt solution) from partially sorted material exiting the separator and maintaining the separated solution in the separator. The separated liquids may further include oils originating in the waste material. First separator **410** is in communication with separator solution control system **494** via conduit(s) **416**. First separator **410**, separator solution control system **494** and conduit(s) **416** are configured for conveying liquid (composed to a large degree of the aqueous salt solution) from separator **410** to separator solution control system **494** for monitoring the content (e.g., specific gravity) of the solution and/or for conveying aqueous salt solution or any ingredients thereof from separator solution control system **494** to separator **410**, for replenishing or otherwise controlling the solution in separator **410**. First separator **410** is optionally further configured for conveying separated materials such as inorganic materials to optional inorganic material bin **492** via optional conduit **414**.

First shredder **420** is configured for shredding (e.g., by cutting blades) partially sorted material received from separator **410** into crudely shredded pieces of about 12 mm in size, and for conveying the shredded partially sorted material to second separator **430** via conduit **422**. Shredder **420** is optionally further configured for conveying liquid from the shredded partially sorted material (e.g., by compressing and/or draining the shredded partially sorted material) via optional conduit **424** to optional liquid control system **490**. The liquid may include oils originating in the waste material.

Second separator **430** contains an aqueous salt solution (e.g., at a volume of about 3-4 m³) and is configured for separating crudely shredded partially sorted

materials received from shredder **420** according to specific gravity as described herein (e.g., configured as a system described in Example 9), and for conveying sorted materials after separation to second shredder **440** via conduit **432**. Second separator **430** is optionally further configured for separating oils which float on a surface of the aqueous salt solution (e.g., by skimming) from the partially sorted materials and aqueous salt solution, second separator **430** optionally comprising a skimmer adapted for skimming oils (e.g., a weir skimmer, oleophilic skimmer and/or metallic skimmer described herein).

Second separator **430** is adapted for partial separation (e.g., by compression and/or drainage) of liquid (composed to a large degree of the aqueous salt solution) from sorted material exiting the separator and maintaining the separated solution in the separator. The separated liquids may further include oils originating in the waste material. Second separator **430** is in communication with separator solution control system **494** via conduit(s) **436**. Second separator **430**, separator solution control system **494** and conduit(s) **436** are configured for conveying liquid (composed to a large degree of the aqueous salt solution) from separator **430** to separator solution control system **494** for monitoring the content (e.g., specific gravity) of the solution and/or for conveying aqueous salt solution or any ingredients thereof from separator solution control system **494** to separator **430**, for replenishing or otherwise controlling the solution in separator **430**. Second separator **430** is optionally further configured for conveying separated materials such as inorganic materials to optional inorganic material bin **492** via optional conduit **434**.

Second shredder **440** is configured for further shredding (e.g., by cutting blades) sorted material received from separator **430** into shredded pieces of about 5-6 mm in size, and for conveying the shredded sorted material to optional mixer **460** via conduit **442** (e.g., a conveyor belt). Shredder **440** is optionally further configured for conveying liquid from the shredded sorted material (e.g., by compressing and/or draining the shredded sorted material) via optional conduit **444** to optional liquid control system **490**. The liquid may include oils originating in the waste material.

Any one or more of first separator **410**, first shredder **420**, second separator **430** and second shredder **440** optionally comprises a screw press configured for compressing partially sorted material exiting the separator and/or shredder, to thereby separate a

portion of the liquids from partially sorted material. Optionally, first shredder **420** and/or second shredder **440** comprise a screw press.

Optional additional material reservoir **450** (e.g., a silo) is configured for conveying an additional material to be added to the sorted material (e.g., an additional material described herein) to mixer **460** via optional conduit **452**. Reservoir **450** may optionally be configured for breaking any lumps in the additional material. Conduit **452** may communicate with mixer **460** separately from conduit **442**, or conduits **452** and **442** may be joined to form a single conduit in communication with mixer **460**. Conduit **452** is optionally configured for conveying the additional material to an optional separator (not shown) for sorting the additional material, after which the sorted additional is conveyed to mixer **460**.

Mixer **460** is configured for mixing sorted material received via conduit **442** and optionally additional material received via conduit **452**, for forming a feedstock. Mixer **460** is optionally configured for mixing the sorted material in an acidic solution (e.g., aqueous hydrochloric acid, pH 2). The acidic solution is optionally sufficiently acidic so as to result in cleavage of lignocellulose in the sorted material to smaller units (e.g., cleavage of polysaccharide to smaller saccharide units). Mixer **460** is optionally further configured for conveying liquid released from the sorted material to optional liquid control system **490** via optional conduit(s) **464**.

Optionally, mixer **460** is a component (e.g., the mixer component) of mixer/reactor **480**, and optional buffer container **470** and optional conduits **462** and **472** are not present.

Alternatively, mixer **460** is configured for conveying the feedstock directly or indirectly to mixer/reactor **480** via optional conduit **462**. Conduit **462** is optionally in direct communication with mixer/reactor **480**.

Alternatively, conduit **462** is in communication with optional buffer container **470**, which is configured (e.g., in a form of a hopper) for conveying feedstock to mixer/reactor **480** via conduit **472** at a controlled rate which is adapted for operation of mixer/reactor **480**. The controlled rate may be different than the rate at which the feedstock is conveyed to container **470** via conduit **462**. Buffer container **470** is optionally further configured for conveying gas released from the feedstock to optional

gas control system **496** via optional conduit **476**, and/or for conveying liquid released from the feedstock to optional liquid control system **490** via optional conduit **474**.

Mixer/reactor **480** is configured for subjecting the feedstock to shear forces and heating as described herein (e.g., configured as described in FIG. 4), and for releasing
5 gas from heated feedstock (e.g., via vent(s)). Mixer/reactor **480** is optionally configured for extruding a processed material.

Mixer/reactor **480** optionally comprises a first zone and second zone for mixing and heating. The first zone is configured for receiving feedstock from conduit **472**,
10 subjecting the feedstock to mixing and heating at a first temperature (e.g., at about 110 °C) sufficient for forming a relatively homogeneous mixture (e.g., kneading), and releasing gas. The second zone is configured for receiving material from the first zone, subjecting the material to mixing with shear forces as described herein and heating at a second temperature (e.g., at about 180-225 °C), and releasing gas, and optionally for extruding a processed material. The second zone is optionally configured as an extruder
15 (e.g., as described herein).

Mixer/reactor **480** optionally comprises at least one mixer adapted for subjecting incoming material to intensive shearing forces, for example, by rotation of intersecting spiral-shaped blades (e.g., as in a Banbury® mixer). Such a mixer may be configured as a first zone of mixer/reactor **480** (as described herein) and/or for receiving material
20 from conduit **472** and conveying material to a first zone of mixer/reactor **480** (as described herein).

Mixer/reactor **480** is optionally in communication with a pelletizer (not shown) configured for preparing pellets from processed material conveyed (e.g., by extrusion) from mixer/reactor **480**.

25 Optionally, gas is conveyed via optional conduit(s) **484** to optional gas control system **496**. Optionally, conduit(s) **484** comprises at least one conduit in communication with a first zone described herein and/or at least one conduit in communication with a second zone described herein.

Separator solution control system **494** is configured for cleaning one or more
30 separator solutions (e.g., by removal of particles of waste material by filtration, removal of oils by any suitable oil-water separation technique, and/or removal of foam, which may be caused, for example, by detergents in waste material), and for controlling an

amount of solution in separator **410** and/or **430**. Solution control system **494** is optionally configured to receive information from one or more monitors (not shown) which detect an amount of solution in separator **410** and/or **430**. Solution control system **494** optionally comprises a plurality (e.g., two) of parallel mechanisms for cleaning solutions, such that the system can remain operative during maintenance of one mechanism (e.g., cleaning and/or replacing a filter and/or oil-water separator).

Solution control system **494** is optionally in communication with a reservoir for collecting oils removed by solution control system **494**. Alternatively or additionally, the reservoir for collecting oils is in communication with first separator **410** and/or second separator **430**, and is for collecting oils separated (e.g., by skimming) in first separator **410** and/or second separator **430**, as described herein.

Optional gas control system **496** is optionally configured for condensing (e.g., forming water from steam) and/or storing at least a portion of gas received from reservoir **400**, container **470** and/or mixer/reactor **480**, and optionally further configured for separating liquids (e.g., water) formed by the condensation. Such a gas (e.g., methane) may have an industrial use (e.g., as a fuel). Optional gas control system **496** is optionally configured to reduce pollution (e.g., air pollution, water pollution and/or soil pollution) by gas received from reservoir **400**, container **470** and/or mixer/reactor **480**, and/or by liquids (e.g., water) formed by the condensation.

Optional liquid control system **490** is configured for collecting and optionally treating a liquid received from reservoir **400**, shredder(s) **420** and/or **440**, mixer **460** and/or container **470**. Such a compound may have an industrial use (e.g., use in feedstock). Liquid control system **490** is optionally further configured for conveying a compound (e.g., carbohydrate) from a liquid to mixer **460** via conduit **464**.

Treating the liquid may optionally comprise concentrating a compound (e.g., carbohydrate) in the liquid (e.g., by filtration and or evaporation of the liquid), fermenting and/or processing the carbohydrate(s) by fermentation, heating, and/or reaction with a reagent (e.g., as described herein).

The salt in the aqueous salt solutions of separator **410** and/or **430** optionally consists essentially of sea salt (e.g., NaCl with some additional salts present). The salt solution is optionally sea water or concentrated sea water or diluted sea water.

Materials comprised by the system are selected to be suitable for operation in a corrosive environment while minimizing galvanic corrosion.

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

All publications, patents and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention. To the extent that section headings are used, they should not be construed as necessarily limiting.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

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WHAT IS CLAIMED IS:

1. A method of processing waste material so as to form a non-particulate processed material, the method comprising:

removing at least a portion of inorganic materials in the waste material, to thereby obtain a sorted material containing at least 90 weight percents of an organic material;

providing a feedstock having a water content of at least 15 weight percents, wherein at least 50 weight percents of the dry weight of said feedstock is said sorted material;

subjecting said feedstock to mixing via shear forces; and

subjecting said feedstock to heating,

wherein:

said removing comprises separating materials according to specific gravity, said separating comprising contacting the waste material with a liquid selected such that said at least a portion of inorganic materials sink; and

the feedstock is subjected to said mixing and said heating without being dried, thereby obtaining a non-particulate processed material.

2. The method of claim 1, wherein at least 90 weight percents of the dry weight of said feedstock is said sorted material.

3. The method of any one of claims 1 to 2, wherein less than 10 % of a volume of said non-particulate processed material consists of particles having a volume of at least 0.2 mm³.

4. The method of any one of claims 1 to 3, wherein said separating materials according to specific gravity comprises obtaining a sorted material containing at least 90 weight percents of material having a specific gravity within a pre-selected range.

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5. The method of claim 4, wherein said pre-selected range is no more than 1.25.

6. The method of any one of claims 1 to 5, wherein said separating materials according to specific gravity further comprises removing at least a portion of a polymer selected from the group consisting of a thermoset polymer and a synthetic polymer having a melting point of at least 250 °C in the waste material, to thereby obtain a sorted material containing at least 90 weight percents of an organic material other than said thermoset polymer and said synthetic polymer having a melting point of at least 250 °C.

7. The method of any one of claims 1 to 6, wherein said water content of said feedstock is at least 40 weight percents.

8. The method of any one of claims 1 to 7, wherein at least 70 weight percents of the dry weight of said feedstock is lignocellulose.

9. The method of any one of claims 1 to 8, wherein no more than 5 weight percents of the dry weight of said feedstock is inorganic material.

10. The method of any one of claims 1 to 9, wherein from 15 to 30 weight percents of the dry weight of said feedstock is synthetic polymers.

11. The method of any one of claims 1 to 10, wherein at least 1 weight of the dry weight of said feedstock is inorganic salts.

12. The method of any one of claims 1 to 11, further comprising contacting the waste material or sorted material with an acidic substance, to thereby provide said feedstock.

13. The method of any one of claims 1 to 12, wherein the processed material comprises a polymeric material.

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14. A method of sorting waste material, the method comprising:
separating materials in the waste material according to specific gravity, the waste material being solid waste comprising a mixture of wood-derived materials, plastics, food and inorganic materials, said separating comprising contacting the waste material with an aqueous liquid selected such that a portion of said waste material sinks, to thereby obtain a sorted material containing at least 90 weight percents of material having a specific gravity within a pre-selected range, wherein said aqueous liquid comprises an aqueous salt solution, and a concentration of the salt in said aqueous salt solution is at least 10 weight percent.
15. The method of claim 14, wherein said pre-selected range is no more than 1.25.
16. The method of any one of claims 1 to 15, further comprising shredding the sorted material subsequent to said contacting the waste material with said liquid.
17. The method of any one of claims 1 to 16, wherein a specific gravity of said liquid is at least 1.10.
18. The method of any one of claims 1 to 17, wherein said liquid comprises an aqueous sodium chloride solution.
19. The method of any one of claims 1 to 18, comprising said contacting the waste material with an aqueous liquid, to thereby obtain a partially sorted material, and further comprising subjecting said partially sorted material to at least one additional cycle of separating materials according to specific gravity, said separating comprising contacting the partially sorted material with an additional liquid, to thereby obtain said sorted material.
20. The method of any one of claims 1 to 19, further comprising separating at least a portion of oils from said sorted material.

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21. A polymeric material obtainable by the method of any one of claims 1 to 12.
22. The polymeric material of claim 21, being a thermoplastic polymeric material.
23. The polymeric material of any one of claims 21 and 22, being characterized by a density below 1.2 gram/cm³.
24. The polymeric material of any one of claims 21 to 23, wherein a concentration of carbon in the material is at least 55 weight percents.
25. The polymeric material of any one of claims 21 to 24, wherein a concentration of oxygen in the material is at least 20 weight percents.
26. The polymeric material of any one of claims 21 to 25, wherein a total concentration of carbon and oxygen in the material is at least 80 weight percents.
27. The polymeric material of any one of claims 21 to 26, wherein a total concentration of carbon, hydrogen and oxygen in the material is at least 90 weight percents.
28. The polymeric material of any one of claims 21 to 27, wherein a total concentration of carbon, hydrogen, oxygen, nitrogen, alkali metal and halogen atoms in the material is at least 93 weight percents.
29. The polymeric material of any one of claims 21 to 28, wherein at least 95 percent of the non-hydrogen atoms in the material are carbon or oxygen atoms.

30. The polymeric material of any one of claims 21 to 29, wherein at least 97 percent of the non-hydrogen atoms in the material are carbon, oxygen, nitrogen, alkali metal or halogen atoms.

31. The polymeric material of any one of claims 21 to 30, wherein a molar concentration of alkali metals in the polymeric material is at least 50 % higher than a molar concentration of alkali metals in the dry weight of said waste material.

32. The polymeric material of any one of claims 21 to 31, wherein a molar concentration of halogens in the polymeric material is at least 50 % higher than a molar concentration of halogens in the dry weight of said waste material.

33. The polymeric material of any one of claims 21 to 32, wherein a melt-flow index of the polymeric material is at least 1 gram per 10 minutes at a temperature of 190 °C.

34. An article-of-manufacturing formed from the polymeric material of any one of claims 21 to 33.

35. An article-of-manufacturing comprising two or more materials adhered to and/or blended with one another, wherein at least one of said materials is the polymeric material of any one of claims 21 to 33.

36. Use of a waste material for the production of the article-of-manufacturing of any one of claims 34 to 35.

37. A system for processing a waste material to form a non-particulate processed material, the system comprising:

a separator configured for removing at least a portion of inorganic materials from the waste material by separating materials in the waste material according to specific gravity, the separator containing a liquid selected such that at least a portion of inorganic

materials sink, to thereby provide a sorted material containing at least 90 weight percents of an organic material;

an apparatus for subjecting a feedstock to mixing via shear forces, said apparatus comprising a first mixing zone and a second mixing zone, each independently being adapted for subjecting the waste material to heating; and

a first vent and a second vent, each being adapted for removing gases released during said mixing and said heating from said apparatus,

the system being configured for providing to said apparatus a feedstock comprising said sorted material, and having a water content of at least 15 weight percents, and

the apparatus being configured for subjecting said feedstock to mixing in said first mixing zone and removing said gases from said first vent, and subsequently subjecting said feedstock to mixing in said second mixing zone and removing said gases from said second vent, to thereby obtain a processed material, wherein the feedstock is subjected to said mixing and said heating without being dried.

38. The system of claim 37, comprising at least one separator configured for separating materials in the waste material according to specific gravity, said at least one separator being configured for obtaining a sorted material containing at least 90 weight percents of a material having a specific gravity within a pre-selected range.

39. The system of claim 38, wherein said pre-selected range is no more than 1.25.

40. The system of any one of claims 37 to 39, being configured for removing at least a portion of a polymer selected from the group consisting of a thermoset polymer and a synthetic polymer having a melting point of at least 250 °C from the waste material, to thereby obtain a sorted material containing at least 90 weight percents of an organic material other than said thermoset polymer and said synthetic polymer having a melting point of at least 250 °C.

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41. The system of any one of claims 37 to 40, wherein said water content of said feedstock is at least 40 weight percents.

42. The system of any one of claims 37 to 41, wherein said first mixing zone and said second mixing zone are each independently adapted for heating said feedstock at a temperature in a range of from 90 °C to 230 °C.

43. The system of any one of claims 37 to 42, wherein said apparatus comprises a screw for effecting said mixing.

44. A system for sorting a waste material, the system comprising:
a separator configured for separating materials in the waste material according to specific gravity, the separator containing a liquid selected such that a portion of said waste material sinks, to thereby obtain a sorted material containing at least 90 weight percents of material having a specific gravity within a pre-selected range, wherein said liquid comprises an aqueous salt solution, and a concentration of the salt in said aqueous salt solution is at least 15 weight percent; and
an apparatus configured for separating at least a portion of liquid from said sorted material by compression.

45. The system of claim 44, wherein said pre-selected range is no more than 1.25.

46. The system of any one of claims 44 to 45, wherein a specific gravity of said liquid is in a range of from 1.15 to 1.25.

47. The system of any one of claims 44 to 46, wherein said liquid comprises an aqueous sodium chloride solution.

48. The system of any one of claims 44 to 47, comprising a first separator configured for separating materials according to specific gravity to thereby obtain a

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partially sorted material, and at least one additional separator configured for subjecting said partially sorted material to at least one additional cycle of separating materials according to specific gravity, said additional separator containing an additional liquid selected such that a portion of said partially sorted material sinks.

49. The system of any one of claims 37 to 48, further comprising at least one apparatus configured for separating oils from said liquid.

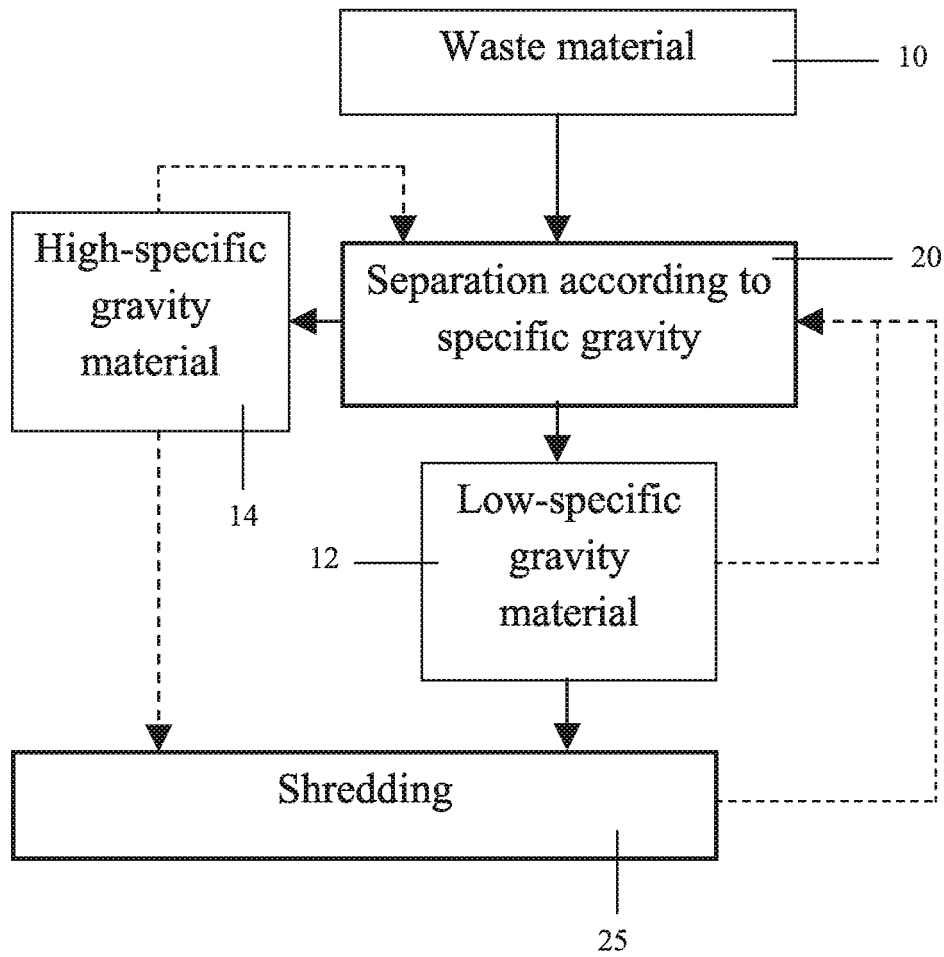


FIG. 1

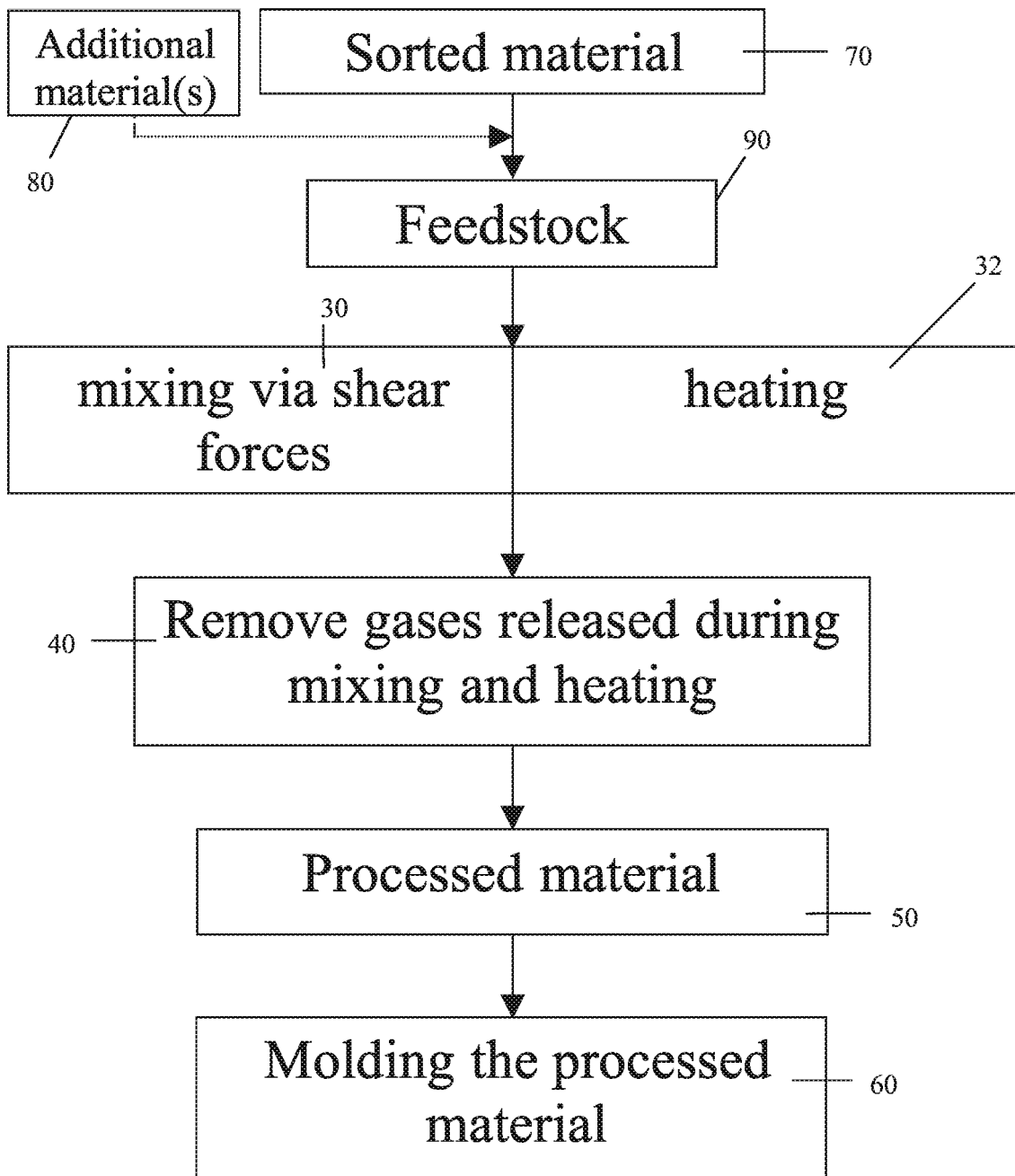


FIG. 2

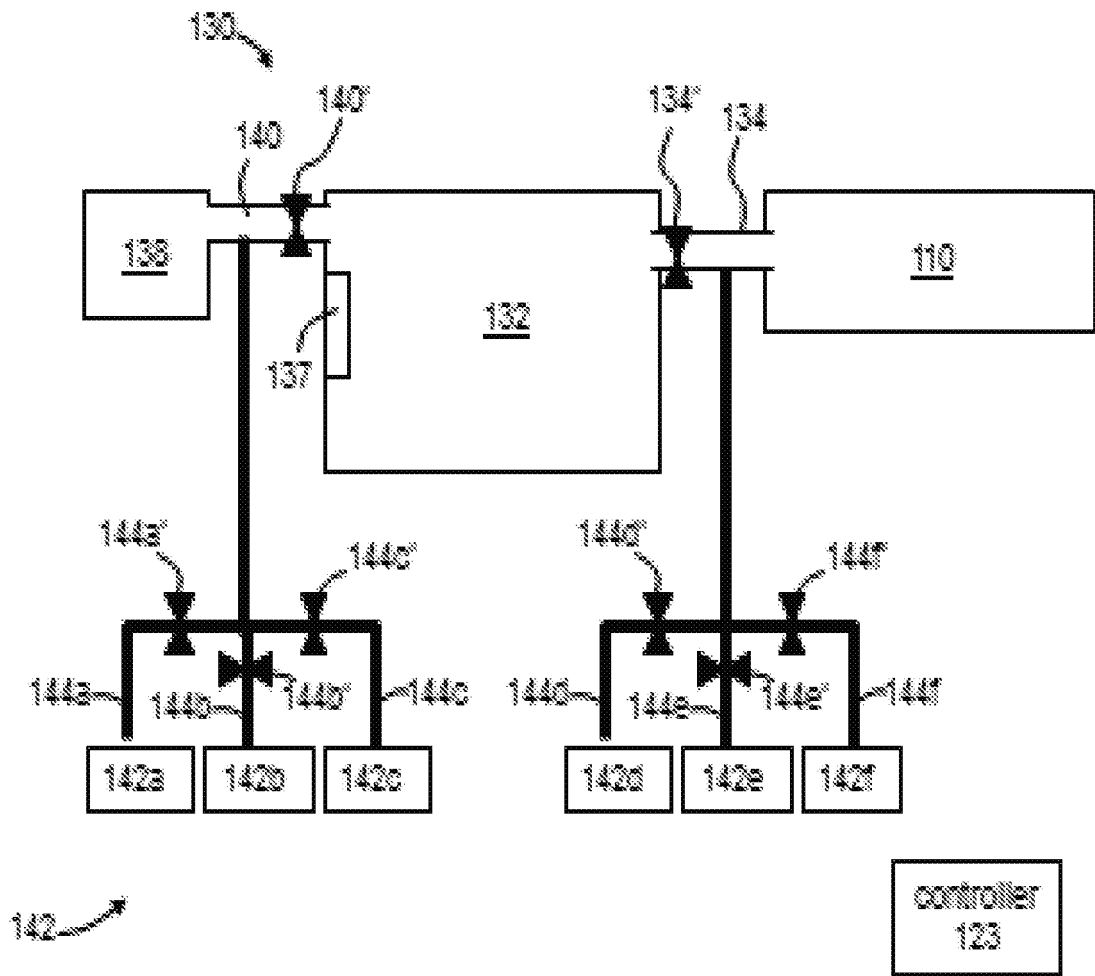
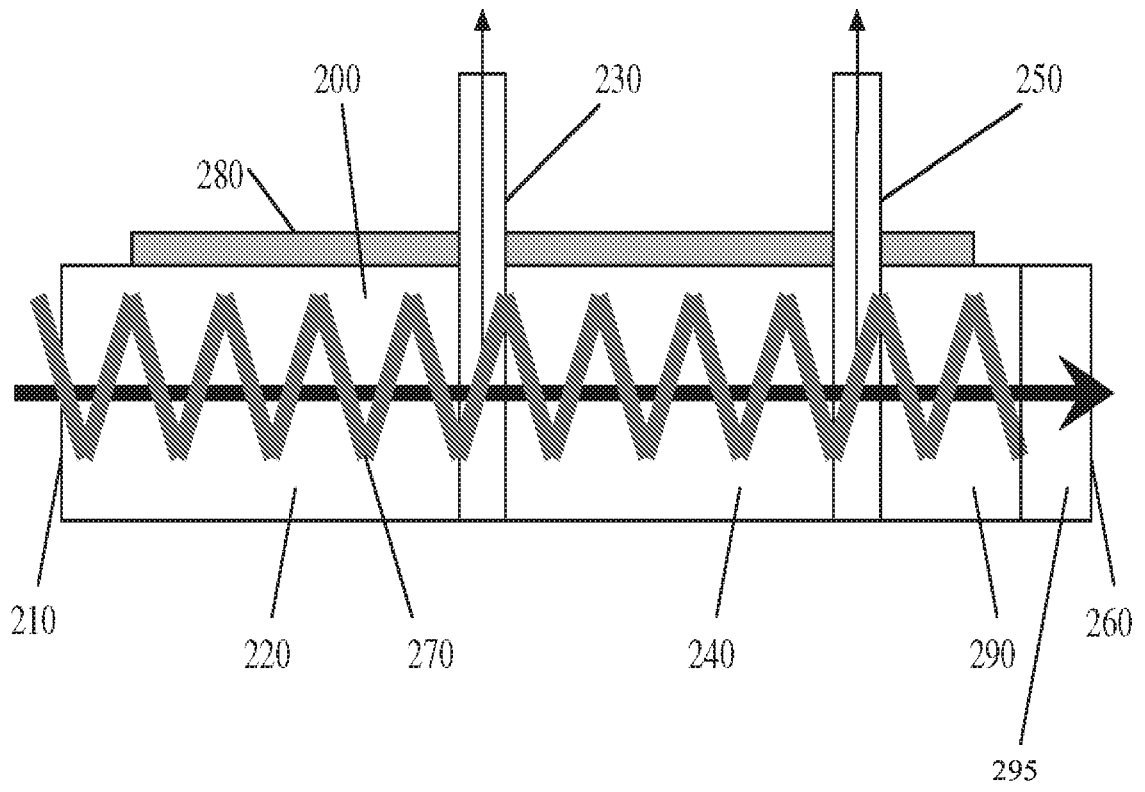


FIG. 3

FIG. 4



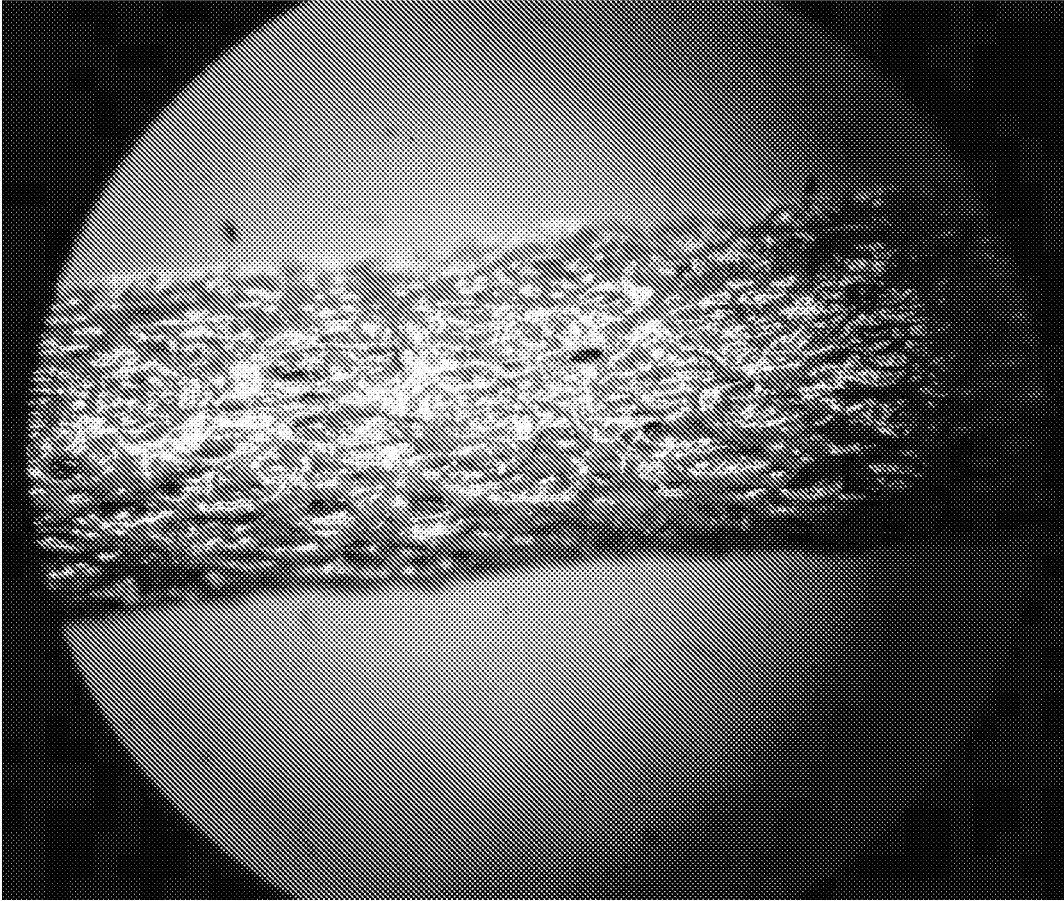


FIG. 5A

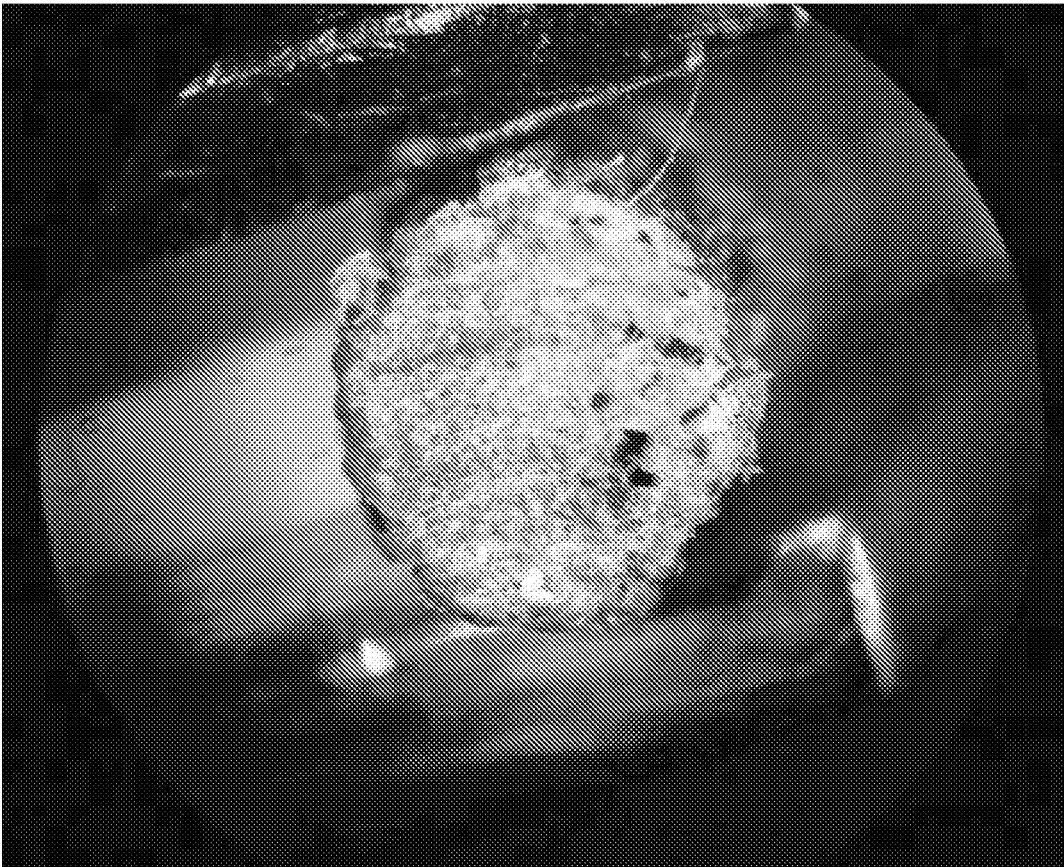


FIG. 5B

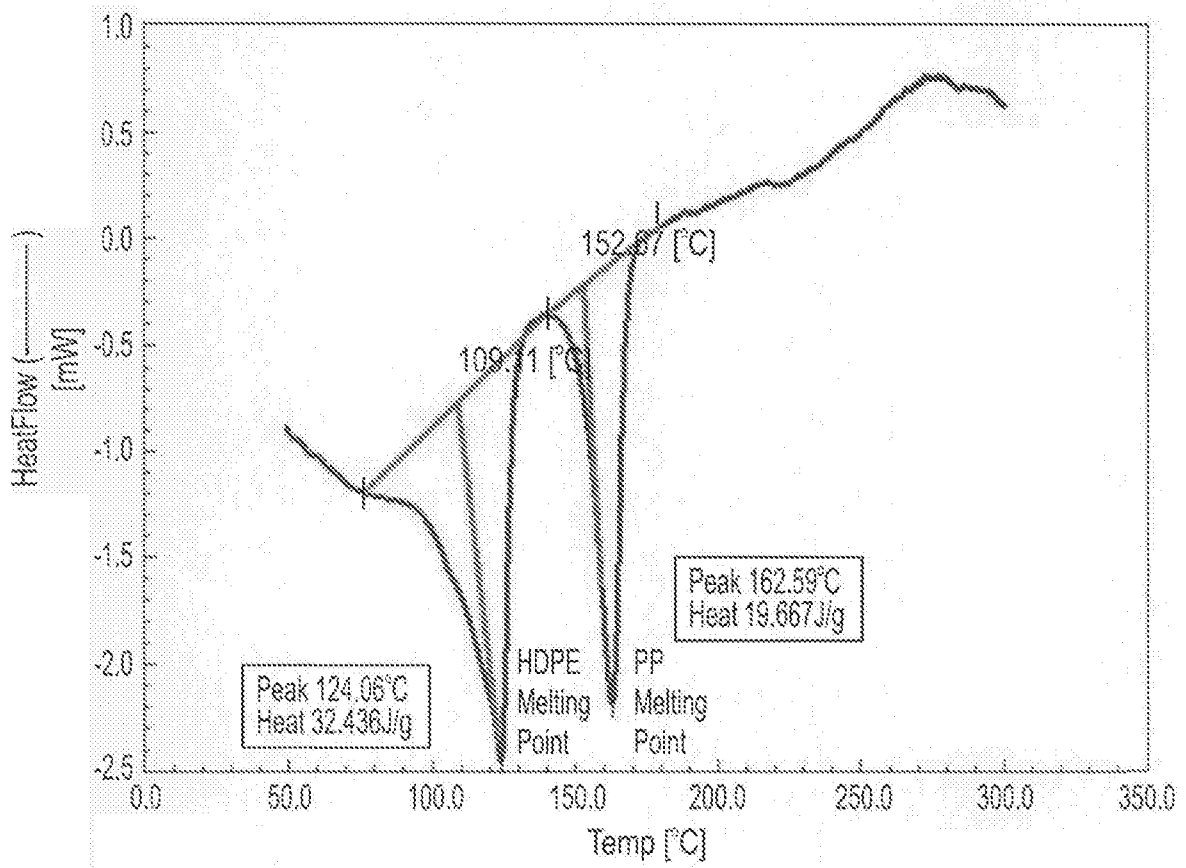


FIG. 6

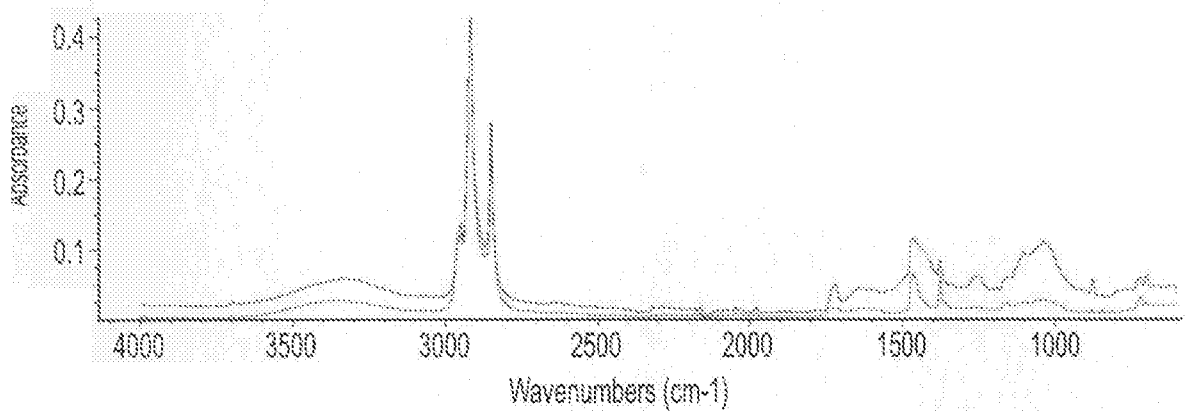


FIG. 7

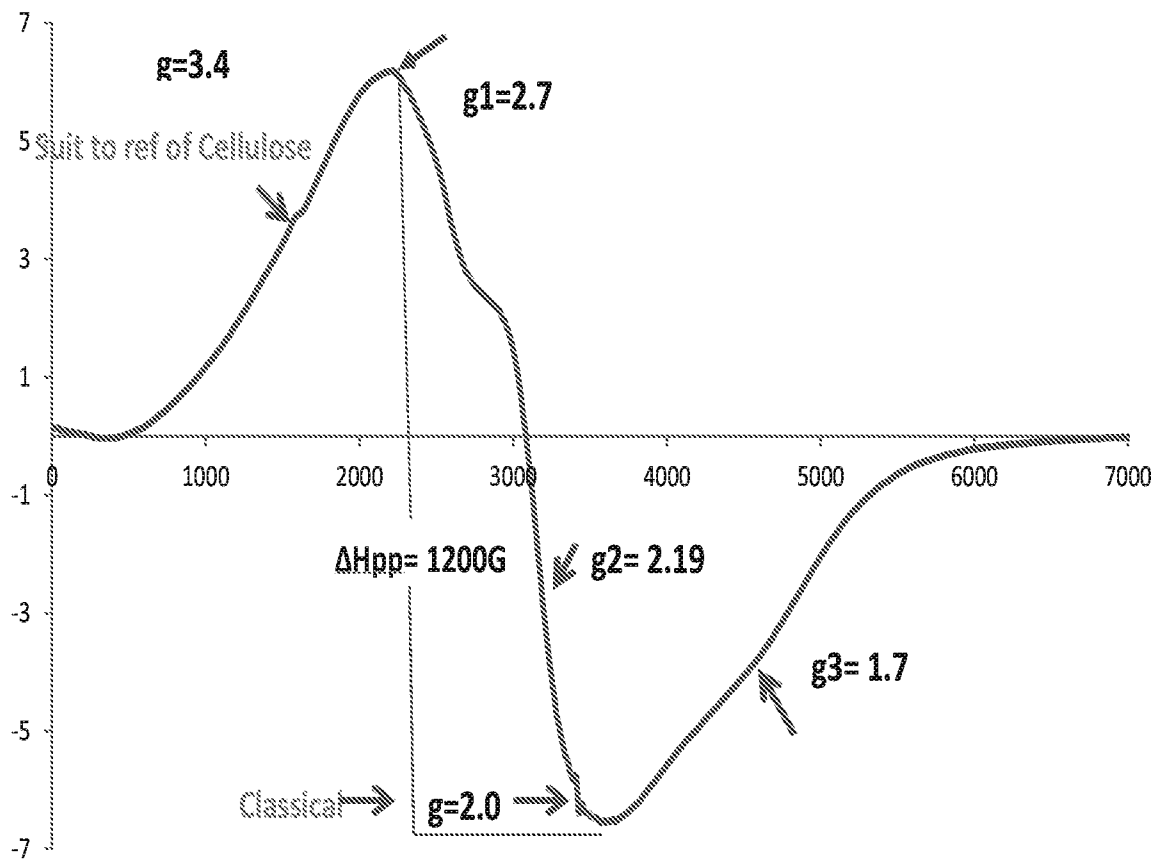


FIG. 8

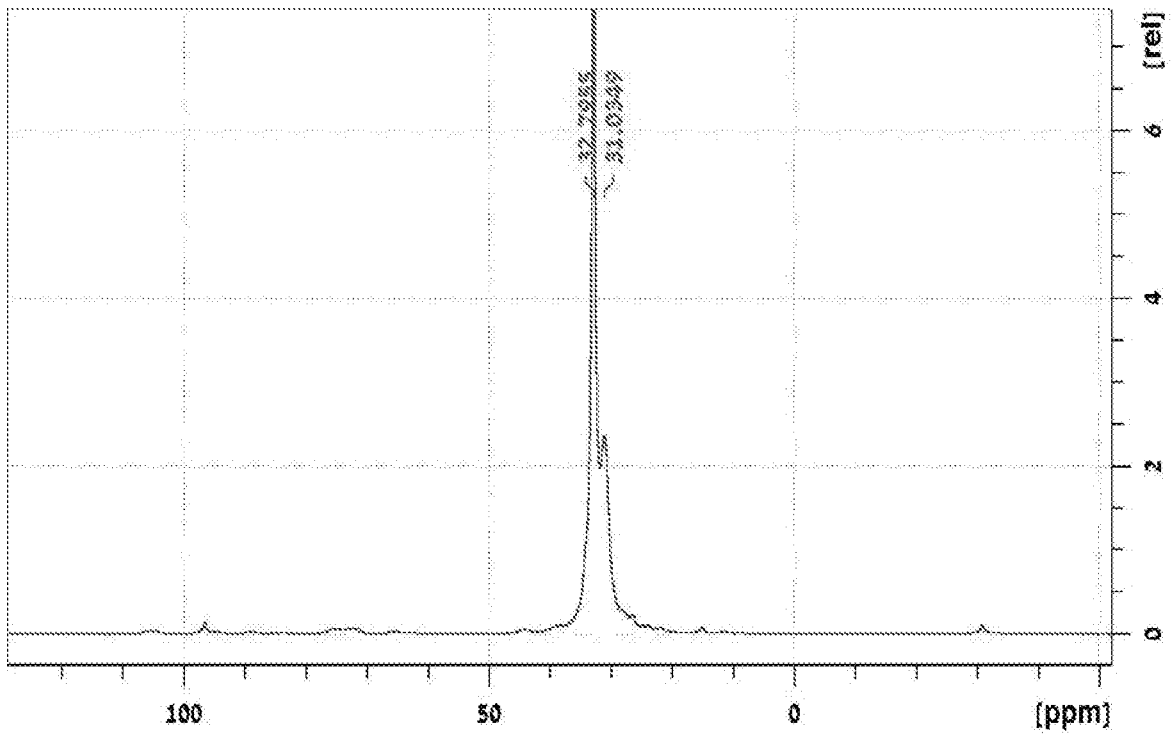


FIG. 9A

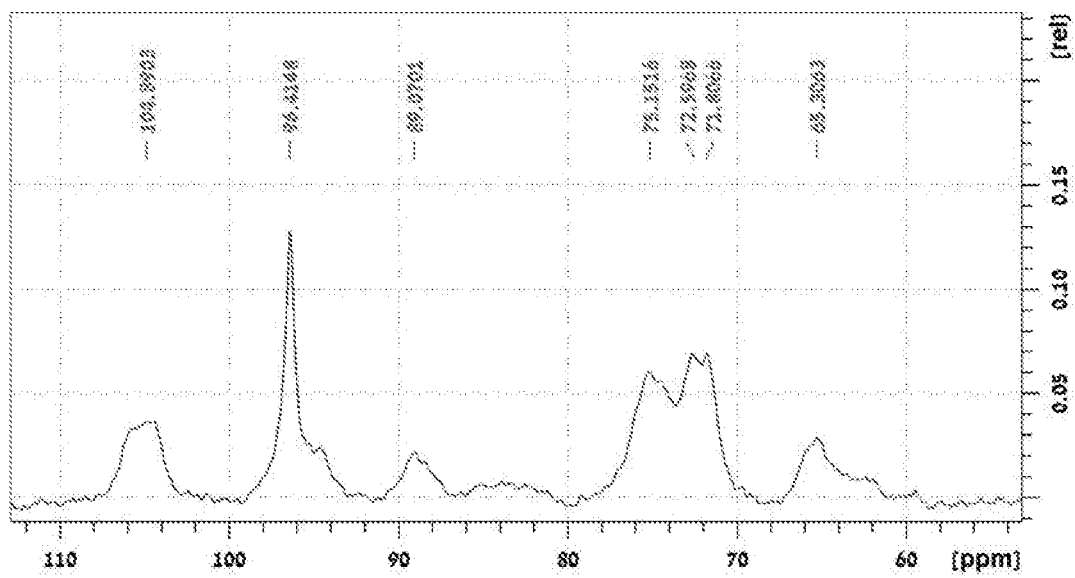


FIG. 9B

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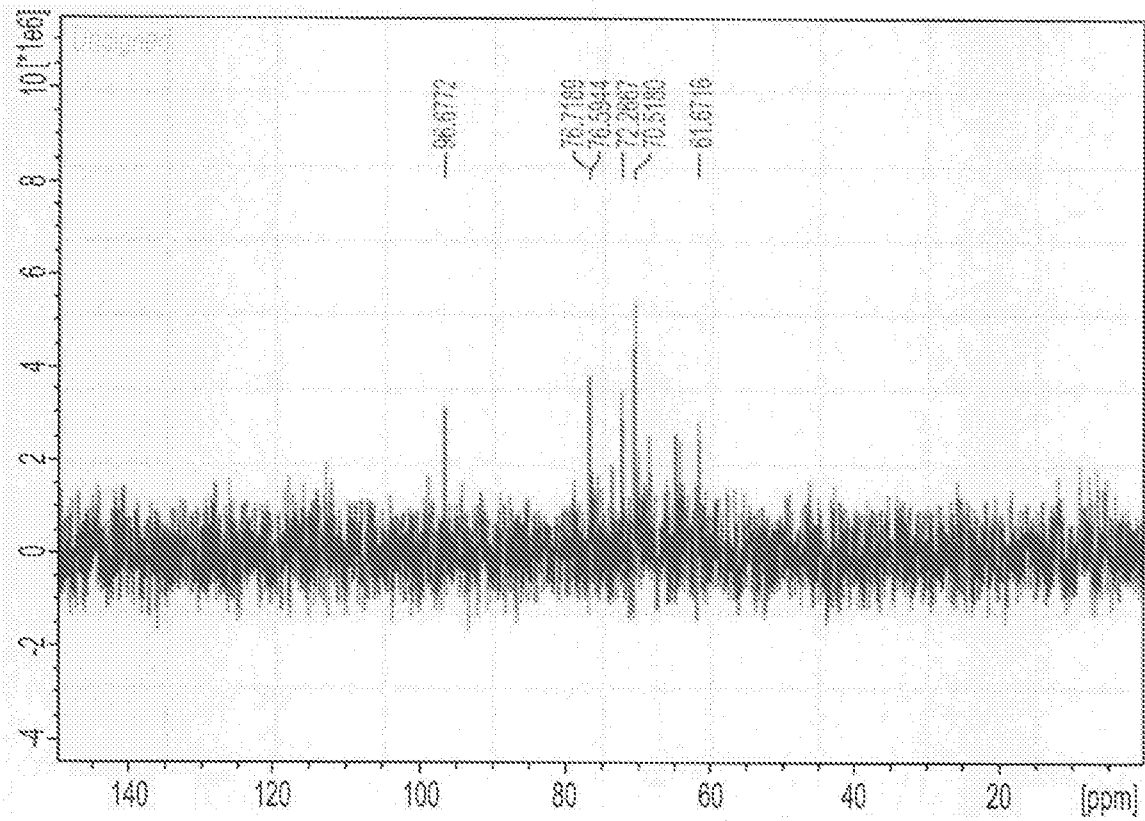


FIG. 10A

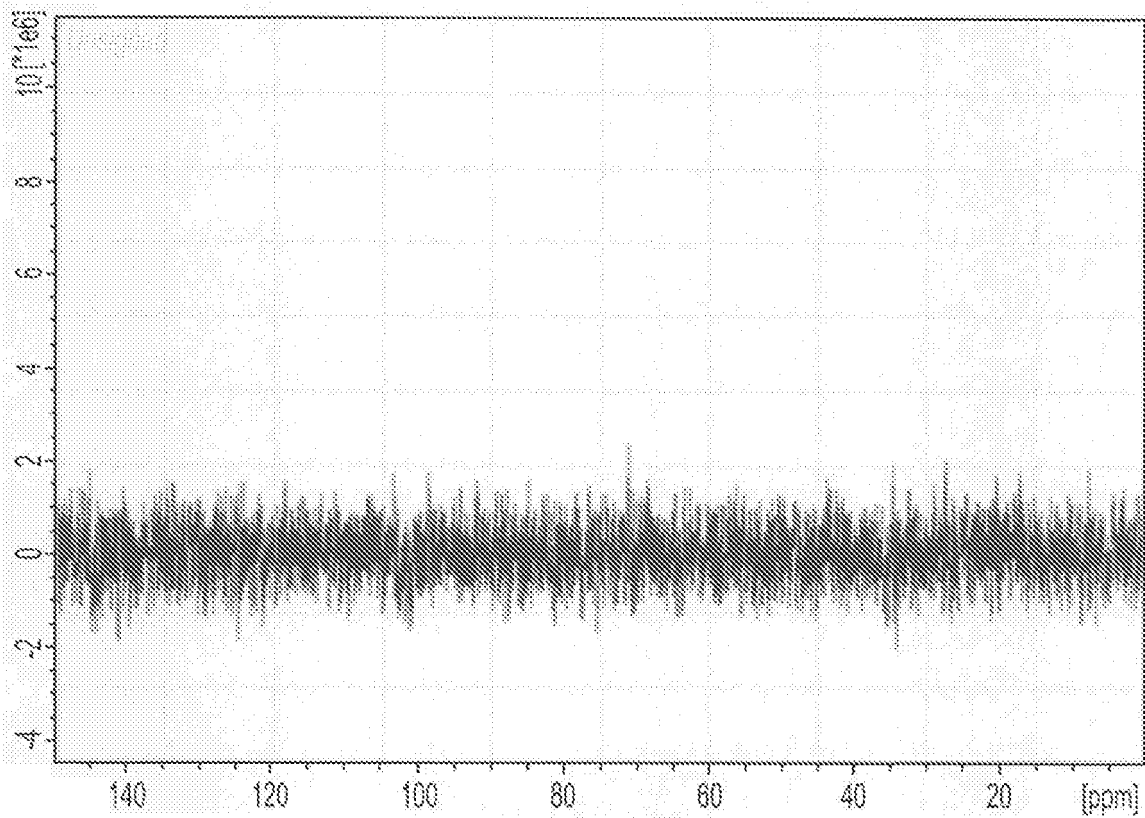
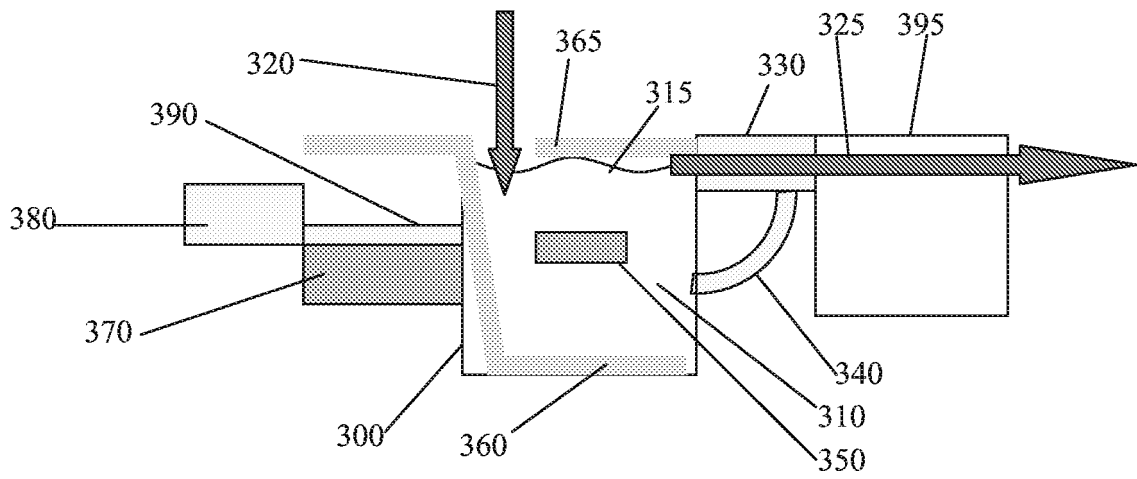


FIG. 10B

FIG. 11



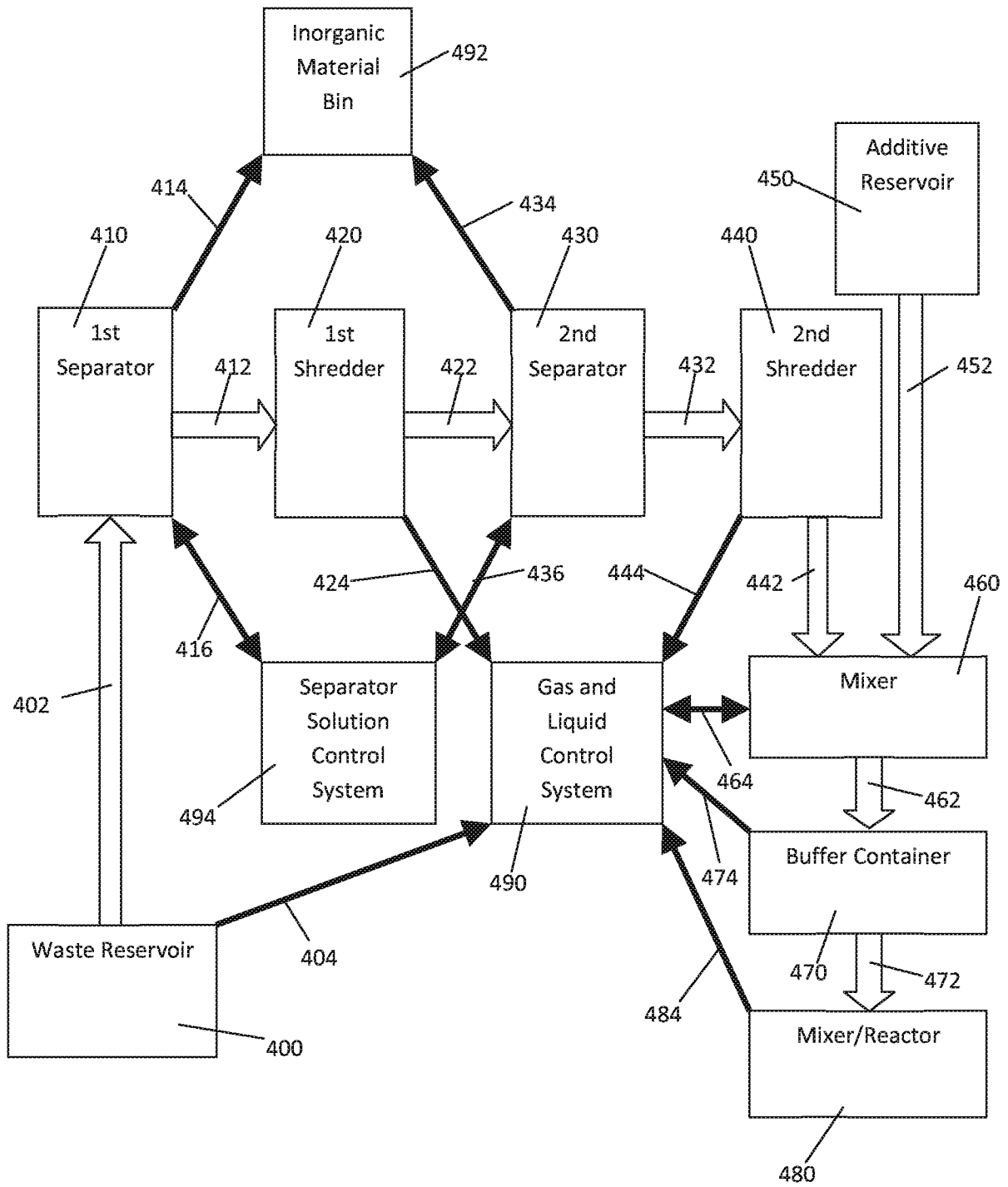


FIG. 12