Innovation, Sciences et Développement économique Canada
Office de la Propriété Intellectuelle du Canada

Innovation, Science and Economic Development Canada
Canadian Intellectual Property Office

CA 3074394 C 2023/01/31

(11)(21) 3 074 394

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2016/03/01

(41) Mise à la disp. pub./Open to Public Insp.: 2016/09/09

(45) Date de délivrance/Issue Date: 2023/01/31

(62) Demande originale/Original Application: 2 977 387

(30) Priorité/Priority: 2015/03/04 (US62/128,175)

(51) Cl.Int./Int.Cl. *D06M 15/00* (2006.01)

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(54) Titre : ELEMENTS FIBREUX, STRUCTURES FIBREUSES ET PRODUITS COMPRENANT UN AGENT DE DISSUASION, ET PROCEDES DE FABRICATION

(54) Title: FIBROUS ELEMENTS, FIBROUS STRUCTURES, AND PRODUCTS COMPRISING A DETERRENT AGENT AND METHODS FOR MAKING SAME

(57) Abrégé/Abstract:
Water-soluble fibrous structures comprising a plurality of water-soluble fibrous elements, wherein the water-soluble fibrous structures further comprise a deterrent agent designed to prevent and/or mitigate the risk of ingestion, for example accidental ingestion, of such water-soluble fibrous structures by humans and/or animals is provided.

ABSTRACT

Water-soluble fibrous structures comprising a plurality of water-soluble fibrous elements, wherein the water-soluble fibrous structures further comprise a deterrent agent designed to prevent and/or mitigate the risk of ingestion, for example accidental ingestion, of such water-soluble fibrous structures by humans and/or animals is provided.

Date Reçue/Date Received 2021-07-30

FIBROUS ELEMENTS, FIBROUS STRUCTURES, AND PRODUCTS COMPRISING A DETERRENT AGENT AND METHODS FOR MAKING SAME

FIELD OF THE INVENTION

The present invention relates to fibrous elements, for example filaments and/or fibers, fibrous structures comprising such fibrous elements, and products comprising such fibrous elements and/or fibrous structures, and more particularly to fibrous elements and/or fibrous structures and/or products comprising one or more deterrent agents and methods for making same.

BACKGROUND OF THE INVENTION

It is known in the art to use bittering agents with films. For example, it is known to coat bittering agents onto a film for example by spraying, printing, and/or powdering the bittering agents onto a surface of the film.

In the fibrous element and/or fibrous structure technology area, there are fibrous elements, for example fibrous elements comprising active agents, and/or fibrous structures comprising such fibrous elements and products comprising the same that are designed for ingestion by humans and/or animals, however, there are also some fibrous elements, even fibrous elements that comprise active agents, and/or fibrous structures comprising such fibrous elements and/or products comprising the same that are not designed for ingestion by human and/or animals. Hence there exists a problem with mitigating the risk of accidental ingestion by humans and/or animals of such fibrous elements and/or fibrous structures and/or products comprising such fibrous elements and/or fibrous structures that are not designed for ingestion. Such fibrous elements and/or fibrous structures and/or products to date have not incorporated deterrent agents, such as bittering agents and/or pungent agents and/or emetic agents, to deter ingestion by humans and/or animals.

Accordingly, one problem faced by formulators of fibrous elements and/or fibrous structures and/or products comprising such fibrous elements and/or fibrous structures, such as those of the present invention that are not designed for ingestion by humans and/or animals is how to prevent and/or mitigate the risk of ingestion, for example accidental ingestion, by humans and/or animals of such fibrous elements and/or fibrous structures and/or products comprising such fibrous elements and/or fibrous structures.

In light of the foregoing, it is clear that there is a need for preventing and/or mitigating the risk of ingestion, for example accidental ingestion, of fibrous elements and/or fibrous structures and/or products comprising such fibrous elements and/or fibrous structures, for example fibrous elements that comprise one or more active agents, that are not designed for ingestion by humans and/or animals by including one or more deterrent agents, such as a bittering agent and/or a pungent agent and/or an emetic agent, within and/or on the fibrous elements and/or fibrous structures and/or products comprising such fibrous elements and/or fibrous structures and methods for making same.

SUMMARY OF THE INVENTION

The present invention fulfills the need described above by providing fibrous elements and/or fibrous structures comprising such fibrous elements and/or products comprising such fibrous elements and/or fibrous structures that are not designed to be ingested by humans and/or animals, for example fibrous elements and/or fibrous structures and/or product that comprise one or more active agents not designed to be ingested by humans and/or animals, to comprise a deterrent agent within and/or on the fibrous elements and/or fibrous structures and/or products.

One solution to the problem identified above is to add one or more deterrent agents to the fibrous elements and/or fibrous structures and/or products, for example fibrous elements and/or fibrous structures and/or products comprising one or more active agents, to deter humans and/or animals from ingesting or attempting to ingest such fibrous elements and/or fibrous structures and/or products of the present invention.

In one example of the present invention, a fibrous element, for example a filament and/or fiber, that is not designed and/or suitable for ingestion by humans and/or animals, wherein the fibrous element comprises one or more fibrous element-forming materials and one or more deterrent agents, for example wherein the one or more deterrent agents are present within the fibrous element, such as a mixture of the fibrous element-forming materials and the deterrent agents, and/or on a surface of the fibrous element such as in the form of a coating composition and/or printed on the surface, is provided.

In another example of the present invention, a fibrous element, for example a filament and/or fiber, that is not designed and/or suitable for ingestion by humans and/or animals, wherein the fibrous element comprises one or more fibrous element-forming materials and one or more active agents, for example present within the fibrous element, such as within a mixture comprising the fibrous element-forming materials, the active agents, and the deterrent agents,

and/or on a surface of the fibrous element such as in the form of a coating composition and/or printed on the surface, such as a mixture of the fibrous element-forming materials and the active agents, for example that are releasable from the fibrous elements when exposed to conditions of intended use, and one or more deterrent agents, for example present within the fibrous element, such as within a mixture comprising the fibrous element-forming materials, the active agents, and the deterrent agents, and/or on a surface of the fibrous element such as in the form of a coating composition and/or printed on the surface, is provided.

In another example of the present invention, a fibrous element-forming composition, for example a filament-forming composition, suitable for producing fibrous elements of the present invention, for example by a spinning process, comprises one or more fibrous element-forming materials, one or more deterrent agents, and optionally, one or more polar solvents (such as water) is provided.

In another example of the present invention, a fibrous element-forming composition, for example a filament-forming composition, suitable for producing fibrous elements of the present invention, for example by a spinning process, comprises one or more fibrous element-forming materials, one or more active agents, one or more deterrent agents, and optionally, one or more polar solvents (such as water) is provided.

In even still another example of the present invention, a fibrous element, for example a filament and/or fiber, that is not designed and/or suitable for ingestion by humans and/or animals, wherein the fibrous element comprises one or more fibrous element-forming materials, one or more active agents, for example a mixture of the fibrous element-forming materials and the active agents, and one or more deterrent agents, for example wherein the one or more deterrent agents are present within the fibrous element, such as within a mixture comprising the fibrous element-forming materials, the active agents, and the deterrent agents, and/or on a surface of the fibrous element such as in the form of a coating composition and/or printed on the surface, wherein the active agents comprise one or more surfactants, one or more enzymes, one or more suds suppressors, and/or one or more perfumes, is provided.

In even still yet another example of the present invention, a fibrous structure comprising one or more fibrous elements, for example filaments and/or fibers, wherein the fibrous structure comprises one or more active agents, for example within one or more fibrous elements, such as in a mixture comprising the fibrous element-forming materials and the active agents, and/or on a surface of one or more fibrous elements and/or within the fibrous structure such as between fibrous elements, for example within the interstices of the fibrous structure (such as a coformed

fibrous structure comprising one or more particles comprising one or more active agents) and/or between two or more fibrous structures that are attached directly or indirectly to one another and/or between two or more layers of fibrous elements that form the fibrous structure and/or on a surface of the fibrous structure and/or on surface of one or more of the fibrous elements, and one or more deterrent agents, for example within one or more fibrous elements, such as within a mixture comprising the fibrous element-forming materials, the active agents, and the deterrent agents, and/or on a surface of one or more fibrous elements and/or within the fibrous structure such as between fibrous elements, for example within the interstices of the fibrous structure (such as a coformed fibrous structure comprising one or more particles comprising one or more deterrent agents) and/or between two or more fibrous structures that are attached directly or indirectly to one another and/or between two or more layers of fibrous elements that form the fibrous structure and/or on a surface of the fibrous structure and/or on surface of one or more of the fibrous elements, is provided.

In yet another example of the present invention, a method for making a fibrous element, for example a filament and/or fiber, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, and one or more deterrent agents, and optionally, one or more polar solvents (such as water); and

b. spinning the fibrous element-forming composition into one or more fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials, the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element, and the one or more deterrent agents is provided. In one example, the total level of the fibrous element-forming materials present in the fibrous element is 80% or less and/or 70% or less and/or 60% or less and/or 50% or less and/or 40% or less and/or 30% or less and/or 20% or less by weight on a dry fibrous element basis and the total level of the active agents present in the fibrous element is 20% or greater and/or 30% or greater and/or 40% or greater 50% or greater and/or 60% or greater and/or 70% or greater and/or 80% or greater by weight on a dry fibrous element basis.

In yet another example of the present invention, a method for making a fibrous element, for example a filament and/or fiber, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, and optionally, one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into one or more fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials, the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element; and

c. applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements, is provided. In one example, the total level of the fibrous element-forming materials present in the fibrous element is 80% or less and/or 70% or less and/or 60% or less and/or 50% or less and/or 40% or less and/or 30% or less and/or 20% or less by weight on a dry fibrous element basis and the total level of the active agents present in the fibrous element is 20% or greater and/or 30% or greater and/or 40% or greater 50% or greater and/or 60% or greater and/or 70% or greater and/or 80% or greater by weight on a dry fibrous element basis.

In yet another example of the present invention, a method for making a fibrous structure, the method comprising the steps of:

a. providing a fibrous structure, for example a fibrous structure comprising one or more fibrous elements of the present invention, and

b. applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of the fibrous structure, is provided.

In yet another example of the present invention, a method for making a fibrous structure, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, one or more deterrent agents, and optionally, one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into one or more fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials, the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element, and the one or more deterrent agents; and

c. collecting a plurality of the fibrous elements on a collection device, such as a belt or fabric, such that the fibrous elements are inter-entangled to form a fibrous structure; and

d. optionally, applying one or more deterrent agents (for example in liquid form

and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements and/or fibrous structure, is provided.

In yet another example of the present invention, a method for making a fibrous structure, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, and optionally, one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into one or more fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials and the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element;

c. applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements; and

d. collecting a plurality of the fibrous elements on a collection device, such as a belt or fabric, such that the fibrous elements are inter-entangled to form a fibrous structure; and

e. optionally, applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of the fibrous structure, is provided.

In yet another example of the present invention, a method for making a fibrous structure, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, and optionally, one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into one or more fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials and the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element;

c. collecting a plurality of the fibrous elements on a collection device, such as a belt or fabric, such that the fibrous elements are inter-entangled to form a fibrous structure; and

d. applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements and/or to a surface of the fibrous structure, is provided.

In even yet another example of the present invention, a method for making a fibrous structure, the method comprises the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, one or more deterrent agents, and optionally, one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into one or more fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials, the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element, and the one or more deterrent agents;

c. collecting a plurality of the fibrous elements on a collection device, such as a belt or fabric, such that the fibrous elements are inter-entangled to form a fibrous structure; and

d. applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements and/or to a surface of the fibrous structure, is provided.

In yet another example of the present invention, a method for making a fibrous structure, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, and optionally, one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into a plurality of fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials and the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element;

c. combining a plurality of particles comprising one or more deterrent agents with a plurality of the fibrous elements to form a mixture; and

d. collecting the mixture on a collection device, such as a belt or fabric, such that the fibrous elements are inter-entangled with the particles to form a fibrous structure; and

e. optionally, applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements and/or to a surface of the fibrous structure, is provided.

In yet another example of the present invention, a method for making a fibrous structure, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials, one or more active agents, one or more deterrent agents, and optionally, one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into a plurality of fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials, the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element, and the one or more deterrent agents;

c. combining a plurality of particles comprising one or more deterrent agents with a plurality of the fibrous elements to form a mixture; and

d. collecting the mixture on a collection device, such as a belt or fabric, such that the fibrous elements are inter-entangled with the particles to form a fibrous structure; and

e. optionally, applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements and/or to a surface of the fibrous structure, is provided.

In yet another example of the present invention, a method for making a fibrous structure, the method comprising the steps of:

a. providing a fibrous element-forming composition comprising one or more fibrous element-forming materials and optionally, one or more active agents, one or more deterrent agents, and/or one or more polar solvents (such as water);

b. spinning the fibrous element-forming composition into a plurality of fibrous elements, for example filaments and/or fibers, comprising the one or more fibrous element-forming materials and optionally, the one or more active agents, for example that are releasable and/or released from the fibrous element when exposed to conditions of intended use of the fibrous element and/or the one or more deterrent agents;

c. combining a plurality of particles comprising one or more active agents and/or one or more deterrent agents with a plurality of the fibrous elements to form a mixture; and

d. collecting the mixture on a collection device, such as a belt or fabric, such that the fibrous elements are inter-entangled with the particles to form a fibrous structure; and

e. optionally, applying one or more deterrent agents (for example in liquid form and/or in solid form, such as a particle comprising the deterrent agent) to a surface of one or more of the fibrous elements and/or to a surface of the fibrous structure, is provided. In one example, one or

more of the particles may comprise a coating composition comprising one or more deterrent agents that coat or partially coat the particles.

In even still yet another example of the present invention, a product, for example a laundry detergent product and/or a dishwashing detergent product and/or a hard surface cleaning product and/or a hair care product comprising one or more fibrous elements and/or one or more fibrous structures of the present invention and one or more deterrent agents is provided. In one example, in addition to the fibrous elements and/or fibrous structures, the product may comprise a film. In one example, the film may comprise one or more deterrent agents present within the film and/or on a surface of the film.

Even though the examples provided herein refer to fibrous elements, for example filaments and/or fibers made from the filaments of the present invention, such as by cutting a filament into fibers, the fibrous structures of the present invention may comprise a mixture of fibrous elements, such as a mixture of both filaments and fibers.

Accordingly, the present invention provides fibrous elements, for example filaments and/or fibers, and/or fibrous structures comprising fibrous elements and/or products comprising such fibrous elements and/or fibrous structures comprising one or more deterrent agents and methods for making same.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic representation of an example of a fibrous element according to the present invention;

Fig. 2 is a schematic representation of an example of a soluble fibrous structure according to the present invention;

Fig. 3 is a schematic representation of an example of a process for making fibrous elements of the present invention;

Fig. 4 is a schematic representation of an example of a die with a magnified view used in the process of Fig. 3;

Fig. 5 is a front view of an example of a setup of equipment used in measuring dissolution according to the present invention;

Fig. 6 is a side view of Fig. 5; and

Fig. 7 is a partial top view of Fig. 5.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

"Fibrous structure" as used herein means a structure that comprises one or more fibrous elements. In one example, a fibrous structure according to the present invention means an association of fibrous elements and particles that together form a structure, such as a unitary structure, capable of performing a function.

The fibrous structures of the present invention may be homogeneous or may be layered. If layered, the fibrous structures may comprise at least two and/or at least three and/or at least four and/or at least five layers, for example one or more fibrous element layers, one or more particle layers and/or one or more fibrous element/particle mixture layers. In one example, in a multiple layer fibrous structure, one or more layers may be formed and/or deposited directly upon an existing layer to form a fibrous structure whereas in a multi-ply fibrous structure, one or more existing fibrous structure plies may be combined, for example via thermal bonding, gluing, embossing, rodding, rotary knife aperturing, needlepunching, knurling, tufting, and/or other mechanical combining process, with one or more other existing fibrous structure plies to form the multi-ply fibrous structure.

In one example, the fibrous structure is a multi-ply fibrous structure that exhibits a basis weight of less than 10000 g/m^2 and/or less than 7500 g/m^2 and/or less than 5000 g/m^2 and/or less than 3000 g/m^2 and/or greater than 50 g/m^2 and/or greater than 100 g/m^2 and/or greater than 250 g/m^2 and/or greater than 500 g/m^2 as measured according to the Basis Weight Test Method described herein.

In one example, the fibrous structure is a sheet of fibrous elements (fibers and/or filaments, such as continuous filaments), of any nature or origin, that have been formed into a fibrous structure by any means, and may be bonded together by any means, with the exception of weaving or knitting. Felts obtained by wet milling are not soluble fibrous structures. In one example, a fibrous structure according to the present invention means an orderly arrangement of filaments within a structure in order to perform a function. In another example, a fibrous structure of the present invention is an arrangement comprising a plurality of two or more and/or three or more fibrous elements that are inter-entangled or otherwise associated with one another to form a fibrous structure. In yet another example, the fibrous structure of the present invention may comprise, in addition to the fibrous elements of the present invention, one or more solid additives, such as particulates and/or fibers.

In one example of the present invention, the fibrous structure of the present invention comprises one or more fibrous elements, for example filaments and/or fibers, wherein the fibrous structure comprises one or more active agents, such as in the form of a liquid and/or a solid for example a particle, within one or more fibrous elements and/or on a surface of one or more fibrous elements and/or within the fibrous structure such as between fibrous elements, for example within the interstices of the fibrous structure and/or between two or more fibrous structures that are attached directly or indirectly to one another and/or between two or more layers of fibrous elements that form the fibrous structure and/or on a surface of the fibrous structure and/or on surface of one or more of the fibrous elements, and one or more deterrent agents, for example within one or more fibrous elements and/or on a surface of one or more fibrous elements and/or within the fibrous structure such as between fibrous elements, for example within the interstices of the fibrous structure and/or between two or more fibrous structures that are attached directly or indirectly to one another and/or between two or more layers of fibrous elements that form the fibrous structure and/or on a surface of the fibrous structure and/or on surface of one or more of the fibrous elements.

In another example, a fibrous structure of the present invention may comprise one or more active agents that are present within the fibrous structure when originally made, but then bloom to a surface of the fibrous structure prior to and/or when exposed to conditions of intended use of the fibrous structure.

In addition to or alternatively, a fibrous structure of the present invention may comprise one or more active agents that are present within the fibrous structure when originally made, but then bloom to a surface of the fibrous structure prior to and/or when exposed to conditions of intended use of the fibrous structure.

The fibrous structure and/or product comprising the fibrous structure may be of a shape and size, for example suitable for dosing in a washing machine and/or dishwashing machine, and comprise a total level (by weight) of active agents such that greater than 1 g and/or greater than 3 g and/or greater than 5 g and/or greater than 8 g and/or greater than 10 g of active agents are delivered during use of the fibrous structure and/or product, such as during washing of clothes in a washing machine and/or sink basin and/or washing of dishes in a dishwashing machine.

In one example, the fibrous structure of the present invention is a "unitary fibrous structure."

"Unitary fibrous structure" as used herein is an arrangement comprising a plurality of two or more and/or three or more fibrous elements that are inter-entangled or otherwise associated

with one another to form a fibrous structure. A unitary fibrous structure of the present invention may be one or more plies within a multi-ply fibrous structure. In one example, a unitary fibrous structure of the present invention may comprise three or more different fibrous elements. In another example, a unitary fibrous structure of the present invention may comprise two different fibrous elements, for example a coformed fibrous structure, upon which a different fibrous elements are deposited to form a fibrous structure comprising three or more different fibrous elements. In one example, a fibrous structure may comprise soluble, for example water-soluble, fibrous elements and insoluble, for example water insoluble fibrous elements.

"Coformed fibrous structure" as used herein means that the fibrous structure comprises a mixture of at least two different materials wherein at least one of the materials comprises a fibrous element and at least one other material comprises a particle, for example a particle comprising an active agent and/or a deterrent agent.

"Soluble fibrous structure" as used herein means the fibrous structure and/or components thereof, for example greater than 0.5% and/or greater than 1% and/or greater than 5% and/or greater than 10% and/or greater than 25% and/or greater than 50% and/or greater than 75% and/or greater than 90% and/or greater than 95% and/or about 100% by weight of the fibrous structure is soluble, for example polar solvent-soluble such as water-soluble. In one example, the soluble fibrous structure comprises fibrous elements wherein at least 50% and/or greater than 75% and/or greater than 90% and/or greater than 95% and/or about 100% by weight of the fibrous elements within the soluble fibrous structure are soluble.

The soluble fibrous structure comprises a plurality of fibrous elements. In one example, the soluble fibrous structure comprises two or more and/or three or more different fibrous elements.

The soluble fibrous structure and/or fibrous elements thereof, for example filaments, making up the soluble fibrous structure may comprise one or more active agents, for example a fabric care active agent, a dishwashing active agent, a hard surface active agent, a hair care active agent, a floor care active agent, a skin care active agent, an oral care active agent, a medicinal active agent, and mixtures thereof. In one example, a soluble fibrous structure and/or fibrous elements thereof of the present invention comprises one or more surfactants, one or more enzymes (such as in the form of an enzyme prill), one or more perfumes and/or one or more suds suppressors. In another example, a soluble fibrous structure and/or fibrous elements thereof of the present invention comprise a builder and/or a chelating agent. In another example, a soluble fibrous structure and/or fibrous elements thereof of the present invention comprise a bleaching

agent (such as an encapsulated bleaching agent). In still another example, a soluble fibrous structure and/or fibrous elements thereof of the present invention comprise one or more surfactants and optionally, one or more perfumes.

In one example, the soluble fibrous structure of the present invention is a water-soluble fibrous structure.

In one example, the soluble fibrous structure of the present invention exhibits a basis weight of less than 10000 g/m^2 and/or less than 5000 g/m^2 and/or less than 4000 g/m^2 and/or less than 2000 g/m^2 and/or less than 1000 g/m^2 and/or less than 500 g/m^2 and/or greater than 10 g/m^2 and/or greater than 25 g/m^2 and/or greater than 50 g/m^2 and/or greater than 100 g/m^2 and/or greater than 250 g/m^2 as measured according to the Basis Weight Test Method described herein.

"Fibrous element" as used herein means an elongate particulate having a length greatly exceeding its average diameter, i.e. a length to average diameter ratio of at least about 10. A fibrous element may be a filament or a fiber. In one example, the fibrous element is a single fibrous element or a yarn comprising a plurality of fibrous elements. In another example, the fibrous element is a single fibrous element.

The fibrous elements of the present invention may be spun from a fibrous element-forming compositions also referred to as fibrous element-forming compositions via suitable spinning process operations, such as meltblowing, spunbonding, electro-spinning, and/or rotary spinning.

The fibrous elements of the present invention may be monocomponent and/or multicomponent. For example, the fibrous elements may comprise bicomponent fibers and/or filaments. The bicomponent fibers and/or filaments may be in any form, such as side-by-side, core and sheath, islands-in-the-sea and the like.

In one example, the fibrous element, which may be a filament and/or a fiber and/or a filament that has been cut to smaller fragments (fibers) of the filament may exhibit a length of greater than or equal to 0.254 cm (0.1 in.) and/or greater than or equal to 1.27 cm (0.5 in.) and/or greater than or equal to 2.54 cm (1.0 in.) and/or greater than or equal to 5.08 cm (2 in.) and/or greater than or equal to 7.62 cm (3 in.) and/or greater than or equal to 10.16 cm (4 in.) and/or greater than or equal to 15.24 cm (6 in.). In one example, a fiber of the present invention exhibits a length of less than 5.08 cm (2 in.).

"Filament" as used herein means an elongate particulate as described above. In one example, a filament exhibits a length of greater than or equal to 5.08 cm (2 in.) and/or greater

than or equal to 7.62 cm (3 in.) and/or greater than or equal to 10.16 cm (4 in.) and/or greater than or equal to 15.24 cm (6 in.).

Filaments are typically considered continuous or substantially continuous in nature. Filaments are relatively longer than fibers. Filaments are relatively longer than fibers. Non-limiting examples of filaments include meltblown and/or spunbond filaments.

In one example, one or more fibers may be formed from a filament of the present invention, such as when the filaments are cut to shorter lengths. Thus, in one example, the present invention also includes a fiber made from a filament of the present invention, such as a fiber comprising one or more fibrous element-forming materials and one or more additives, such as active agents. Therefore, references to filament and/or filaments of the present invention herein also include fibers made from such filament and/or filaments unless otherwise noted. Fibers are typically considered discontinuous in nature relative to filaments, which are considered continuous in nature.

Non-limiting examples of fibrous elements include meltblown and/or spunbond fibrous elements. Non-limiting examples of polymers that can be spun into fibrous elements include natural polymers, such as starch, starch derivatives, cellulose, such as rayon and/or lyocell, and cellulose derivatives, hemicellulose, hemicellulose derivatives, and synthetic polymers including, but not limited to thermoplastic polymer fibrous elements, such as polyesters, nylons, polyolefins such as polypropylene filaments, polyethylene filaments, and biodegradable thermoplastic fibers such as polylactic acid filaments, polyhydroxyalkanoate filaments, polyesteramide filaments and polycaprolactone filaments. Depending upon the polymer and/or composition from which the fibrous elements are made, the fibrous elements may be soluble or insoluble.

"Fibrous element-forming composition" as used herein means a composition that is suitable for making a fibrous element, for example a filament, of the present invention such as by meltblowing and/or spunbonding. The fibrous element-forming composition comprises one or more fibrous element-forming materials that exhibit properties that make them suitable for spinning into a fibrous element, for example a filament. In one example, the fibrous element-forming material comprises a polymer. In addition to one or more fibrous element-forming materials, the fibrous element-forming composition may comprise one or more additives, for example one or more active agents. In addition, the fibrous element-forming composition may comprise one or more polar solvents, such as water, into which one or more, for example all, of the fibrous element-forming materials and/or one or more, for example all, of the active agents are dissolved and/or dispersed.

In one example as shown in Fig. 1 a fibrous element 10, for example a filament, of the present invention made from a fibrous element-forming composition of the present invention is such that one or more active agents 12, may be present in the fibrous element 10, for example filament, rather than on the fibrous element 10, such as a coating. The total level of fibrous element-forming materials and total level of active agents present in the fibrous element-forming composition may be any suitable amount so long as the fibrous elements, for example filaments, of the present invention are produced therefrom. In addition to the active agents 12 being present within the fibrous element 10, the fibrous element 10 may comprise one or more deterrent agents (not shown) present within and/or on a surface of the fibrous element. Further, in addition to the active agents 12 being present within the fibrous element 10 or alternatively, the fibrous element 10 may comprise one or more active agents 12 on a surface of the fibrous element 10.

In another example, a fibrous element of the present invention may comprise one or more active agents that are present in the fibrous element when originally made, but then bloom to a surface of the fibrous element prior to and/or when exposed to conditions of intended use of the fibrous element.

"Fibrous element-forming material" as used herein means a material, such as a polymer or monomers capable of producing a polymer that exhibits properties suitable for making a fibrous element. In one example, the fibrous element-forming material comprises one or more substituted polymers such as an anionic, cationic, zwitterionic, and/or nonionic polymer. In another example, the polymer may comprise a hydroxyl polymer, such as a polyvinyl alcohol ("PVOH") and/or a polysaccharide, such as starch and/or a starch derivative, such as an ethoxylated starch and/or acid-thinned starch. In another example, the polymer may comprise polyethylenes and/or terephthalates. In yet another example, the fibrous element-forming material is a polar solvent-soluble material.

"Particle" as used herein means a solid additive, such as a powder, granule, encapsulate, microcapsule, and/or prill. In one example, the fibrous elements and/or fibrous structures of the present invention may comprise one or more particles. The particles may be intra-fibrous element (within the fibrous elements, like the active agents and/or deterrent agents), on a surface of the fibrous element, such as a coating composition, and/or inter-fibrous element (between fibrous elements within a fibrous structure, for example a soluble fibrous structure). Non-limiting examples of fibrous elements and/or fibrous structures comprising particles are described in US 2013/0172226 . In one example, the particle exhibits a median particle size of 1600 μm or less as measured according to the Median

Particle Size Test Method described herein. In another example, the particle exhibits a median particle size of from about 1 μm to about 1600 μm and/or from about 1 μm to about 800 μm and/or from about 5 μm to about 500 μm and/or from about 10 μm to about 300 μm and/or from about 10 μm to about 100 μm and/or from about 10 μm to about 50 μm and/or from about 10 μm to about 30 μm as measured according to the Median Particle Size Test Method described herein. The shape of the particle can be in the form of spheres, rods, plates, tubes, squares, rectangles, discs, stars, fibers or have regular or irregular random forms.

"Deterrent agent-containing particle" as used herein means a solid additive comprising one or more deterrent agents. In one example, the deterrent agent-containing particle is a deterrent agent in the form of a particle (in other words, the particle comprises 100% deterrent agent(s)). The deterrent agent-containing particle may exhibit a median particle size of 1600 μm or less as measured according to the Median Particle Size Test Method described herein. In another example, the active agent-containing particle exhibits a median particle size of from about 1 μm to about 1600 μm and/or from about 1 μm to about 800 μm and/or from about 5 μm to about 500 μm and/or from about 10 μm to about 300 μm and/or from about 10 μm to about 100 μm and/or from about 10 μm to about 50 μm and/or from about 10 μm to about 30 μm as measured according to the Median Particle Size Test Method described herein. In one example, one or more of the deterrent agents is in the form of a particle that exhibits a median particle size of 20 μm or less as measured according to the Median Particle Size Test Method described herein.

"Active agent-containing particle" as used herein means a solid additive comprising one or more active agents. In one example, the active agent-containing particle is an active agent in the form of a particle (in other words, the particle comprises 100% active agent(s)). The active agent-containing particle may exhibit a median particle size of 1600 μm or less as measured according to the Median Particle Size Test Method described herein. In another example, the active agent-containing particle exhibits a median particle size of from about 1 μm to about 1600 μm and/or from about 1 μm to about 800 μm and/or from about 5 μm to about 500 μm and/or from about 10 μm to about 300 μm and/or from about 10 μm to about 100 μm and/or from about 10 μm to about 50 μm and/or from about 10 μm to about 30 μm as measured according to the Median Particle Size Test Method described herein. In one example, one or more of the active agents is in the form of a particle that exhibits a median particle size of 20 μm or less as measured according to the Median Particle Size Test Method described herein.

In one example of the present invention, the fibrous structure comprises a plurality of particles, for example active agent-containing particles, and a plurality of fibrous elements in a weight ratio of particles, for example active agent-containing particles, to fibrous elements of 1:100 or greater and/or 1:50 or greater and/or 1:10 or greater and/or 1:3 or greater and/or 1:2 or greater and/or 1:1 or greater and/or from about 7:1 to about 1:100 and/or from about 7:1 to about 1:50 and/or from about 7:1 to about 1:10 and/or from about 7:1 to about 1:3 and/or from about 6:1 to 1:2 and/or from about 5:1 to about 1:1 and/or from about 4:1 to about 1:1 and/or from about 3:1 to about 1.5:1.

In another example of the present invention, the fibrous structure comprises a plurality of particles, for example active agent-containing particles, and a plurality of fibrous elements in a weight ratio of particles, for example active agent-containing particles, to fibrous elements of from about 7:1 to about 1:1 and/or from about 7:1 to about 1.5:1 and/or from about 7:1 to about 3:1 and/or from about 6:1 to about 3:1.

In yet another example of the present invention, the fibrous structure comprises a plurality of particles, for example active agent-containing particles, and a plurality of fibrous elements in a weight ratio of particles, for example active agent-containing particles, to fibrous elements of from about 1:1 to about 1:100 and/or from about 1:2 to about 1:50 and/or from about 1:3 to about 1:50 and/or from about 1:3 to about 1:10.

In another example, the fibrous structure of the present invention comprises a plurality of particles, for example active agent-containing particles, at a particle basis weight of greater than 1 g/m^2 and/or greater than 10 g/m^2 and/or greater than 20 g/m^2 and/or greater than 30 g/m^2 and/or greater than 40 g/m^2 and/or from about 1 g/m^2 to about 5000 g/m^2 and/or to about 3500 g/m^2 and/or to about 2000 g/m^2 and/or from about 1 g/m^2 to about 1000 g/m^2 and/or from about 10 g/m^2 to about 400 g/m^2 and/or from about 20 g/m^2 to about 300 g/m^2 and/or from about 30 g/m^2 to about 200 g/m^2 and/or from about 40 g/m^2 to about 100 g/m^2 as measured by the Basis Weight Test Method described herein.

In another example, the fibrous structure of the present invention comprises a plurality of fibrous elements at a basis weight of greater than 1 g/m^2 and/or greater than 10 g/m^2 and/or greater than 20 g/m^2 and/or greater than 30 g/m^2 and/or greater than 40 g/m^2 and/or from about 1 g/m^2 to about 10000 g/m^2 and/or from about 10 g/m^2 to about 5000 g/m^2 and/or to about 3000 g/m^2 and/or to about 2000 g/m^2 and/or from about 20 g/m^2 to about 2000 g/m^2 and/or from about 30 g/m^2 to about 1000 g/m^2 and/or from about 30 g/m^2 to about 500 g/m^2 and/or from about 30 g/m^2 to about 300 g/m^2 and/or from about 40 g/m^2 to about 100 g/m^2 and/or from about 40 g/m^2

to about 80 g/m^2 as measured by the Basis Weight Test Method described herein. In one example, the fibrous structure comprises two or more layers wherein fibrous elements are present in at least one of the layers at a basis weight of from about 1 g/m^2 to about 500 g/m^2.

"Additive" as used herein means any material present in the fibrous element of the present invention that is not a fibrous element-forming material. In one example, an additive comprises an active agent. In yet another example, an additive comprises a deterrent agent. In another example, an additive comprises a processing aid. In still another example, an additive comprises a filler. In one example, an additive comprises any material present in the fibrous element that its absence from the fibrous element would not result in the fibrous element losing its fibrous element structure, in other words, its absence does not result in the fibrous element losing its solid form. In another example, an additive, for example an active agent, comprises a non-polymer material.

In another example, an additive comprises a plasticizer for the fibrous element. Non-limiting examples of suitable plasticizers for the present invention include polyols, copolyols, polycarboxylic acids, polyesters and dimethicone copolyols. Examples of useful polyols include, but are not limited to, glycerin, diglycerin, propylene glycol, ethylene glycol, butylene glycol, pentylene glycol, cyclohexane dimethanol, hexanediol, 2,2,4-trimethylpentane-1,3-diol, polyethylene glycol (200-600), pentaerythritol, sugar alcohols such as sorbitol, manitol, lactitol and other mono- and polyhydric low molecular weight alcohols (e.g., C2-C8 alcohols); mono di- and oligo-saccharides such as fructose, glucose, sucrose, maltose, lactose, high fructose corn syrup solids, and dextrins, and ascorbic acid.

In one example, the plasticizer includes glycerin and/or propylene glycol and/or glycerol derivatives such as propoxylated glycerol. In still another example, the plasticizer is selected from the group consisting of glycerin, ethylene glycol, polyethylene glycol, propylene glycol, glycidol, urea, sorbitol, xylitol, maltitol, sugars, ethylene bisformamide, amino acids, sorbates, and mixtures thereof

In another example, an additive comprises a crosslinking agent suitable for crosslinking one or more of the fibrous element-forming materials present in the fibrous elements of the present invention. In one example, the crosslinking agent comprises a crosslinking agent capable of crosslinking hydroxyl polymers together, for example via the hydroxyl polymers hydroxyl moieties. Non-limiting examples of suitable crosslinking agents include imidazolidinones, polycarboxylic acids and mixtures thereof. In one example, the crosslinking agent comprises a urea glyoxal adduct crosslinking agent, for example a dihydroxyimidazolidinone, such as

dihydroxyethylene urea ("DHEU"). A crosslinking agent can be present in the fibrous element-forming composition and/or fibrous element of the present invention to control the fibrous element's solubility and/or dissolution in a solvent, such as a polar solvent.

In another example, an additive comprises a rheology modifier, such as a shear modifier and/or an extensional modifier. Non-limiting examples of rheology modifiers include but not limited to polyacrylamide, polyurethanes and polyacrylates that may be used in the fibrous elements of the present invention. Non-limiting examples of rheology modifiers are commercially available from The Dow Chemical Company (Midland, MI).

In yet another example, an additive comprises one or more colors and/or dyes that are incorporated into the fibrous elements of the present invention to provide a visual signal when the fibrous elements are exposed to conditions of intended use and/or when an active agent is released from the fibrous elements and/or when the fibrous element's morphology changes.

In still yet another example, an additive comprises one or more release agents and/or lubricants. Non-limiting examples of suitable release agents and/or lubricants include fatty acids, fatty acid salts, fatty alcohols, fatty esters, sulfonated fatty acid esters, fatty amine acetates, fatty amide, silicones, aminosilicones, fluoropolymers, and mixtures thereof. In one example, the release agents and/or lubricants are applied to the fibrous element, in other words, after the fibrous element is formed. In one example, one or more release agents/lubricants are applied to the fibrous element prior to collecting the fibrous elements on a collection device to form a soluble fibrous structure. In another example, one or more release agents/lubricants are applied to a soluble fibrous structure formed from the fibrous elements of the present invention prior to contacting one or more soluble fibrous structures, such as in a stack of soluble fibrous structures. In yet another example, one or more release agents/lubricants are applied to the fibrous element of the present invention and/or soluble fibrous structure comprising the fibrous element prior to the fibrous element and/or soluble fibrous structure contacting a surface, such as a surface of equipment used in a processing system so as to facilitate removal of the fibrous element and/or soluble fibrous structure and/or to avoid layers of fibrous elements and/or soluble fibrous structures of the present invention sticking to one another, even inadvertently. In one example, the release agents/lubricants comprise particulates.

In even still yet another example, an additive comprises one or more anti-blocking and/or detackifying agents. Non-limiting examples of suitable anti-blocking and/or detackifying agents include starches, starch derivatives, crosslinked polyvinylpyrrolidone, crosslinked cellulose,

microcrystalline cellulose, silica, metallic oxides, calcium carbonate, talc, mica, and mixtures thereof.

"Conditions of intended use" as used herein means the temperature, physical, chemical, and/or mechanical conditions that a fibrous element of the present invention is exposed to when the fibrous element is used for one or more of its designed purposes. For example, if a fibrous element and/or a soluble fibrous structure comprising a fibrous element are designed to be used in a washing machine for laundry care purposes, the conditions of intended use will include that temperature, chemical, physical and/or mechanical conditions present in a washing machine, including any wash water, during a laundry washing operation. In another example, if a fibrous element and/or a soluble fibrous structure comprising a fibrous element are designed to be used by a human as a shampoo for hair care purposes, the conditions of intended use will include that temperature, chemical, physical and/or mechanical conditions present during the shampooing of the human's hair. Likewise, if a fibrous element and/or soluble fibrous structure comprising a fibrous element is designed to be used in a dishwashing operation, by hand or by a dishwashing machine, the conditions of intended use will include the temperature, chemical, physical and/or mechanical conditions present in a dishwashing water and/or dishwashing machine, during the dishwashing operation.

"Active agent" as used herein means an additive that produces an intended effect in an environment external to a fibrous element and/or soluble fibrous structure comprising the fibrous element of the present, such as when the fibrous element is exposed to conditions of intended use of the fibrous element and/or soluble fibrous structure comprising the fibrous element. In one example, an active agent comprises an additive that treats a surface, such as a hard surface (i.e., kitchen countertops, bath tubs, toilets, toilet bowls, sinks, floors, walls, teeth, cars, windows, mirrors, dishes) and/or a soft surface (i.e., fabric, hair, skin, carpet, crops, plants,). In another example, an active agent comprises an additive that creates a chemical reaction (i.e., foaming, fizzing, coloring, warming, cooling, lathering, disinfecting and/or clarifying and/or chlorinating, such as in clarifying water and/or disinfecting water and/or chlorinating water). In yet another example, an active agent comprises an additive that treats an environment (i.e., deodorizes, purifies, perfumes air). In one example, the active agent is formed in situ, such as during the formation of the fibrous element containing the active agent, for example the fibrous element may comprise a water-soluble polymer (e.g., starch) and a surfactant (e.g., anionic surfactant), which may create a polymer complex or coacervate that functions as the active agent used to treat fabric surfaces.

"Treats" as used herein with respect to treating a surface means that the active agent provides a benefit to a surface or environment. Treats includes regulating and/or immediately improving a surface's or environment's appearance, cleanliness, smell, purity and/or feel. In one example treating in reference to treating a keratinous tissue (for example skin and/or hair) surface means regulating and/or immediately improving the keratinous tissue's cosmetic appearance and/or feel. For instance, "regulating skin, hair, or nail (keratinous tissue) condition" includes: thickening of skin, hair, or nails (e.g., building the epidermis and/or dermis and/or sub-dermal [e.g., subcutaneous fat or muscle] layers of the skin, and where applicable the keratinous layers of the nail and hair shaft) to reduce skin, hair, or nail atrophy, increasing the convolution of the dermal-epidermal border (also known as the rete ridges), preventing loss of skin or hair elasticity (loss, damage and/or inactivation of functional skin elastin) such as elastosis, sagging, loss of skin or hair recoil from deformation; melanin or non-melanin change in coloration to the skin, hair, or nails such as under eye circles, blotching (e.g., uneven red coloration due to, e.g., rosacea) (hereinafter referred to as "red blotchiness"), sallowness (pale color), discoloration caused by telangiectasia or spider vessels, and graying hair.

In another example, treating means removing stains and/or odors from fabric articles, such as clothes, towels, linens, and/or hard surfaces, such as countertops and/or dishware including pots and pans.

"Fabric care active agent" as used herein means an active agent that when applied to fabric provides a benefit and/or improvement to the fabric. Non-limiting examples of benefits and/or improvements to fabric include cleaning (for example by surfactants), stain removal, stain reduction, wrinkle reduction, color restoration, static control, wrinkle resistance, permanent press, wear reduction, wear resistance, pill removal, pill resistance, soil removal, soil resistance (including soil release), shape retention, shrinkage reduction, softness, fragrance, anti-bacterial, anti-viral, odor resistance, and odor removal.

"Dishwashing active agent" as used herein means an active agent that when applied to dishware, glassware, pots, pans, utensils, and/or cooking sheets provides a benefit and/or improvement to the dishware, glassware, plastic items, pots, pans and/or cooking sheets. Non-limiting example of benefits and/or improvements to the dishware, glassware, plastic items, pots, pans, utensils, and/or cooking sheets include food and/or soil removal, cleaning (for example by surfactants) stain removal, stain reduction, grease removal, water spot removal and/or water spot prevention, glass and metal care, sanitization, shining, and polishing.

"Hard surface active agent" as used herein means an active agent when applied to floors, countertops, sinks, windows, mirrors, showers, baths, and/or toilets provides a benefit and/or improvement to the floors, countertops, sinks, windows, mirrors, showers, baths, and/or toilets. Non-limiting example of benefits and/or improvements to the floors, countertops, sinks, windows, mirrors, showers, baths, and/or toilets include food and/or soil removal, cleaning (for example by surfactants), stain removal, stain reduction, grease removal, water spot removal and/or water spot prevention, limescale removal, disinfection, shining, polishing, and freshening.

"Beauty benefit active agent," as used herein, refers to an active agent that can deliver one or more beauty benefits.

"Skin care active agent" as used herein, means an active agent that when applied to the skin provides a benefit or improvement to the skin. It is to be understood that skin care active agents are useful not only for application to skin, but also to hair, scalp, nails and other mammalian keratinous tissue.

"Hair care active agent" as used herein, means an active agent that when applied to mammalian hair provides a benefit and/or improvement to the hair. Non-limiting examples of benefits and/or improvements to hair include softness, static control, hair repair, dandruff removal, dandruff resistance, hair coloring, shape retention, hair retention, and hair growth.

"Weight ratio" as used herein means the dry fibrous element, for example filament, basis and/or dry fibrous element-forming material (g or %) on a dry weight basis in the fibrous element, for example filament, to the weight of additive, such as active agent(s) (g or %) on a dry weight basis in the fibrous element, for example filament.

"Hydroxyl polymer" as used herein includes any hydroxyl-containing polymer that can be incorporated into a fibrous element of the present invention, for example as a fibrous element-forming material. In one example, the hydroxyl polymer of the present invention includes greater than 10% and/or greater than 20% and/or greater than 25% by weight hydroxyl moieties.

"Biodegradable" as used herein means, with respect to a material, such as a fibrous element as a whole and/or a polymer within a fibrous element, such as a fibrous element-forming material, that the fibrous element and/or polymer is capable of undergoing and/or does undergo physical, chemical, thermal and/or biological degradation in a municipal solid waste composting facility such that at least 5% and/or at least 7% and/or at least 10% of the original fibrous element and/or polymer is converted into carbon dioxide after 30 days as measured according to the OECD (1992) Guideline for the Testing of Chemicals 301B; Ready Biodegradability – CO_2 Evolution (Modified Sturm Test) Test.

"Non-biodegradable" as used herein means, with respect to a material, such as a fibrous element as a whole and/or a polymer within a fibrous element, such as a fibrous element-forming material, that the fibrous element and/or polymer is not capable of undergoing physical, chemical, thermal and/or biological degradation in a municipal solid waste composting facility such that at least 5% of the original fibrous element and/or polymer is converted into carbon dioxide after 30 days as measured according to the OECD (1992) Guideline for the Testing of Chemicals 301B; Ready Biodegradability – CO_2 Evolution (Modified Sturm Test) Test.

"Non-thermoplastic" as used herein means, with respect to a material, such as a fibrous element as a whole and/or a polymer within a fibrous element, such as a fibrous element-forming material, that the fibrous element and/or polymer exhibits no melting point and/or softening point, which allows it to flow under pressure, in the absence of a plasticizer, such as water, glycerin, sorbitol, urea and the like.

"Non-thermoplastic, biodegradable fibrous element" as used herein means a fibrous element that exhibits the properties of being biodegradable and non-thermoplastic as defined above.

"Non-thermoplastic, non-biodegradable fibrous element" as used herein means a fibrous element that exhibits the properties of being non-biodegradable and non-thermoplastic as defined above.

"Thermoplastic" as used herein means, with respect to a material, such as a fibrous element as a whole and/or a polymer within a fibrous element, such as a fibrous element-forming material, that the fibrous element and/or polymer exhibits a melting point and/or softening point at a certain temperature, which allows it to flow under pressure, in the absence of a plasticizer

"Thermoplastic, biodegradable fibrous element" as used herein means a fibrous element that exhibits the properties of being biodegradable and thermoplastic as defined above.

"Thermoplastic, non-biodegradable fibrous element" as used herein means a fibrous element that exhibits the properties of being non-biodegradable and thermoplastic as defined above.

"Non-cellulose-containing" as used herein means that less than 5% and/or less than 3% and/or less than 1% and/or less than 0.1% and/or 0% by weight of cellulose polymer, cellulose derivative polymer and/or cellulose copolymer is present in fibrous element. In one example, "non-cellulose-containing" means that less than 5% and/or less than 3% and/or less than 1% and/or less than 0.1% and/or 0% by weight of cellulose polymer is present in fibrous element.

"Polar solvent-soluble material" as used herein means a material that is miscible in a polar solvent. In one example, a polar solvent-soluble material is miscible in alcohol and/or water. In other words, a polar solvent-soluble material is a material that is capable of forming a stable (does not phase separate for greater than 5 minutes after forming the homogeneous solution) homogeneous solution with a polar solvent, such as alcohol and/or water at ambient conditions.

"Alcohol-soluble material" as used herein means a material that is miscible in alcohol. In other words, a material that is capable of forming a stable (does not phase separate for greater than 5 minutes after forming the homogeneous solution) homogeneous solution with an alcohol at ambient conditions.

"Water-soluble material" as used herein means a material that is miscible in water. In other words, a material that is capable of forming a stable (does not separate for greater than 5 minutes after forming the homogeneous solution) homogeneous solution with water at ambient conditions.

"Non-polar solvent-soluble material" as used herein means a material that is miscible in a non-polar solvent. In other words, a non-polar solvent-soluble material is a material that is capable of forming a stable (does not phase separate for greater than 5 minutes after forming the homogeneous solution) homogeneous solution with a non-polar solvent.

"Ambient conditions" as used herein means 73°F ± 4°F (about 23°C ± 2.2°C) and a relative humidity of 50% ± 10%.

"Weight average molecular weight" as used herein means the weight average molecular weight as determined using the Weight Average Molecular Weight Test Method described herein.

"Length" as used herein, with respect to a fibrous element, means the length along the longest axis of the fibrous element from one terminus to the other terminus. If a fibrous element has a kink, curl or curves in it, then the length is the length along the entire path of the fibrous element.

"Diameter" as used herein, with respect to a fibrous element, is measured according to the Diameter Test Method described herein. In one example, a fibrous element of the present invention exhibits a diameter of less than 100 μm and/or less than 75 μm and/or less than 50 μm and/or less than 25 μm and/or less than 20 μm and/or less than 15 μm and/or less than 10 μm and/or less than 6 μm and/or greater than 1 μm and/or greater than 3 μm.

"Triggering condition" as used herein in one example means anything, as an act or event, that serves as a stimulus and initiates or precipitates a change in the fibrous element, such as a loss or altering of the fibrous element's physical structure and/or a release of an additive, such as an active agent. In another example, the triggering condition may be present in an environment, such as water, when a fibrous element and/or soluble fibrous structure and/or film of the present invention are added to the water. In other words, nothing changes in the water except for the fact that the fibrous element and/or soluble fibrous structure and/or film of the present invention are added to the water.

"Morphology changes" as used herein with respect to a fibrous element's morphology changing means that the fibrous element experiences a change in its physical structure. Non-limiting examples of morphology changes for a fibrous element of the present invention include dissolution, melting, swelling, shrinking, breaking into pieces, exploding, lengthening, shortening, and combinations thereof. The fibrous elements of the present invention may completely or substantially lose their fibrous element physical structure or they may have their morphology changed or they may retain or substantially retain their fibrous element physical structure as they are exposed to conditions of intended use.

"By weight on a dry fibrous element basis and/or dry soluble fibrous structure basis" means that the weight of the fibrous element and/or soluble fibrous structure measured immediately after the fibrous element and/or soluble fibrous structure has been conditioned in a conditioned room at a temperature of 23°C ± 1°C and a relative humidity of 50% ± 2% for 2 hours. In one example, "by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis" means that the fibrous element and/or soluble fibrous structure comprises less than 20% and/or less than 15% and/or less than 10% and/or less than 7% and/or less than 5% and/or less than 3% and/or to 0% and/or to greater than 0% based on the weight of the fibrous element and/or soluble fibrous structure of moisture, such as water, for example free water, as measured according to the Water Content Test Method described herein.

"Total level" as used herein, for example with respect to the total level of one or more active agents present in the fibrous element and/or soluble fibrous structure, means the sum of the weights or weight percent of all of the subject materials, for example active agents. In other words, a fibrous element and/or soluble fibrous structure may comprise 25% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of an anionic surfactant, 15% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of a nonionic surfactant, 10% by weight of a chelant, and 5% of a perfume so that the total level of active

agents present in the fibrous element is greater than 50%; namely 55% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis.

"Detergent product" as used herein means a solid form, for example a rectangular solid, sometimes referred to as a sheet, that comprises one or more active agents, for example a fabric care active agent, a dishwashing active agent, a hard surface active agent, and mixtures thereof. In one example, a detergent product of the present invention comprises one or more surfactants, one or more enzymes, one or more perfumes and/or one or more suds suppressors. In another example, a detergent product of the present invention comprises a builder and/or a chelating agent. In another example, a detergent product of the present invention comprises a bleaching agent.

In one example, the detergent product comprises a fibrous structure, for example a soluble fibrous structure.

"Different from" or "different" as used herein means, with respect to a material, such as a fibrous element as a whole and/or a fibrous element-forming material within a fibrous element and/or an active agent within a fibrous element, that one material, such as a fibrous element and/or a fibrous element-forming material and/or an active agent, is chemically, physically and/or structurally different from another material, such as a fibrous element and/or a fibrous element-forming material and/or an active agent. For example, a fibrous element-forming material in the form of a filament is different from the same fibrous element-forming material in the form of a fiber. Likewise, starch is different from cellulose. However, different molecular weights of the same material, such as different molecular weights of a starch, are not different materials from one another for purposes of the present invention.

"Random mixture of polymers" as used herein means that two or more different fibrous element-forming materials are randomly combined to form a fibrous element. Accordingly, two or more different fibrous element-forming materials that are orderly combined to form a fibrous element, such as a core and sheath bicomponent fibrous element, is not a random mixture of different fibrous element-forming materials for purposes of the present invention.

"Associate," "Associated," "Association," and/or "Associating" as used herein with respect to fibrous elements and/or particle means combining, either in direct contact or in indirect contact, fibrous elements and/or particles such that a fibrous structure is formed. In one example, the associated fibrous elements and/or particles may be bonded together for example by adhesives and/or thermal bonds. In another example, the fibrous elements and/or particles may

be associated with one another by being deposited onto the same fibrous structure making belt and/or patterned belt.

As used herein, the articles "a" and "an" when used herein, for example, "an anionic surfactant" or "a fiber" is understood to mean one or more of the material that is claimed or described.

All percentages and ratios are calculated by weight unless otherwise indicated. All percentages and ratios are calculated based on the total composition unless otherwise indicated.

Unless otherwise noted, all component or composition levels are in reference to the active level of that component or composition, and are exclusive of impurities, for example, residual solvents or by-products, which may be present in commercially available sources.

Fibrous Structure

The fibrous structures, for example soluble fibrous structures, of the present invention comprise a plurality of fibrous elements, for example a plurality of filaments, one or more active agents and one or more deterrent agents. In one example, the plurality of fibrous elements is inter-entangled to form a fibrous structure, for example a soluble fibrous structure.

In one example of the present invention, the fibrous structure is a soluble fibrous structure.

In one example of the present invention, the soluble fibrous structure is a water-soluble fibrous structure.

In another example of the present invention, the fibrous structure is an apertured fibrous structure. In one example, the fibrous structure is a water-soluble fibrous structure comprising a plurality of apertures. The apertures may be arranged in a non-random, repeating pattern within the fibrous structures of the present invention.

When present in the fibrous structures, the apertures may be of virtually any shape and size. In one example, the apertures are generally round or oblong shaped, in a regular pattern of spaced apart openings. The apertures can each have a diameter of from about 0.1 to about 2 mm and/or from about 0.5 to about 1 mm. The apertures may form an open area within an apertured, water-soluble fibrous structure of from about 0.5% to about 25% and/or from about 1% to about 20% and/or from about 2% to about 10%. It is believed that the benefits of the present invention can be realized with non-repeating and/or non-regular patterns of apertures having various shapes and sizes. Aperturing of fibrous structures, for example water-soluble fibrous structures, can be accomplished by any number of techniques. For example, aperturing can be accomplished by

various processes involving bonding and stretching, such as those described in U.S. Pat. Nos. 3,949,127 and 5,873,868. In one embodiment, the apertures may be formed by forming a plurality of spaced, melt stabilized regions, and then ring-rolling the fibrous structure to stretch the fibrous structure and form apertures in the melt stabilized regions, as described in U.S. Pat. Nos. 5,628,097 and 5,916,661. In another embodiment, apertures can be formed in a multilayer, fibrous structure configuration by the method described in U.S. Pat. Nos. 6,830,800 and 6,863,960.

Still another process for aperturing fibrous structures is described in U.S. Pat. No. 8,241,543 entitled "Method And Apparatus For Making An Apertured Fibrous structure".

In one example, the fibrous structure, for example soluble fibrous structure, comprises a plurality of identical or substantially identical from a compositional perspective of fibrous elements according to the present invention. In another example, the fibrous structure, for example soluble fibrous structure, may comprise two or more different fibrous elements according to the present invention. Non-limiting examples of differences in the fibrous elements may be physical differences such as differences in diameter, length, texture, shape, rigidness, elasticity, and the like; chemical differences such as crosslinking level, solubility, melting point, Tg, active agent, fibrous element-forming material, color, level of active agent, basis weight, level of fibrous element-forming material, presence of any coating on fibrous element, biodegradable or not, hydrophobic or not, contact angle, and the like; differences in whether the fibrous element loses its physical structure when the fibrous element is exposed to conditions of intended use; differences in whether the fibrous element's morphology changes when the fibrous element is exposed to conditions of intended use; and differences in rate at which the fibrous element releases one or more of its active agents when the fibrous element is exposed to conditions of intended use. In one example, two or more fibrous elements and/or particles within the soluble fibrous structure may comprise different active agents. This may be the case where the different active agents may be incompatible with one another, for example an anionic surfactant (such as a shampoo active agent) and a cationic surfactant (such as a hair conditioner active agent).

In another example, the fibrous structure, for example soluble fibrous structure, may exhibit different regions, such as different regions of basis weight, density, and/or caliper. In yet another example, the fibrous structure, for example soluble fibrous structure, may comprise texture on one or more of its surfaces. A surface of the fibrous structure, for example soluble

fibrous structure, may comprise a pattern, such as a non-random, repeating pattern. The fibrous structure, for example soluble fibrous structure, may be embossed with an emboss pattern.

In one example, the fibrous structure may comprise discrete regions of fibrous elements that differ from other parts of the soluble fibrous structure. Non-limiting examples of different regions within fibrous structures are described in U.S. Published Patent Application Nos. 2013/0171421 and 2013/0167305.

The fibrous structure of the present invention may comprise a plurality of particles, for example particles comprising active agents, particles comprising deterrent agents, and particles comprising both active agents and deterrent agents. Non-limiting examples of fibrous structures comprising particles comprising active agents are described in U.S. Published Patent Application No. 2013/0172226.

The fibrous structure of the present invention may be used as is or may be coated with one or more active agents and/or one or more deterrent agents.

In one example, the fibrous structure of the present invention exhibits a thickness of greater than 0.01 mm and/or greater than 0.05 mm and/or greater than 0.1 mm and/or to about 100 mm and/or to about 50 mm and/or to about 20 mm and/or to about 10 mm and/or to about 5 mm and/or to about 2 mm and/or to about 0.5 mm and/or to about 0.3 mm as measured by the Thickness Test Method described herein.

In another example, the fibrous structure of the present invention exhibits a Geometric Mean (GM) Tensile Strength of about 200 g/cm or more, and/or about 500 g/cm or more, and/or about 1000 g/cm or more, and/or about 1500 g/cm or more, and/or about 2000 g/cm or more and/or less than 5000 g/cm and/or less than 4000 g/cm and/or less than 3000 g/cm and/or less than 2500 g/cm as measured according to the Tensile Test Method described herein.

In another example, the fibrous structure of the present invention exhibits a Geometric Mean (GM) Peak Elongation of less than 1000% and/or less than 800% and/or less than 650% and/or less than 550% and/or less than 500% and/or less than 250% and/or less than 100% as measured according to the Tensile Test Method described herein.

In another example, the fibrous structure of the present invention exhibits a Geometric Mean (GM) Tangent Modulus of less than 5000 g/cm and/or less than 3000 g/cm and/or greater than 100 g/cm and/or greater than 500 g/cm and/or greater than 1000 g/cm and/or greater than 1500 g/cm as measured according to the Tensile Test Method described herein.

In another example, the fibrous structure of the present invention exhibits a Geometric Mean (GM) Secant Modulus of less than less than 5000 g/cm and/or less than 3000 g/cm and/or

less than 2500 g/cm and/or less than 2000 g/cm and/or less than 1500 g/cm and/or greater than 100 g/cm and/or greater than 300 g/cm and/or greater than 500 g/cm as measured according to the Tensile Test Method described herein.

One or more, and/or a plurality of fibrous elements of the present invention may form a fibrous structure by any suitable process known in the art. The fibrous structure may be used to deliver active agents from the fibrous elements of the present invention when the fibrous structure is exposed to conditions of intended use of the fibrous elements and/or fibrous structure.

The fibrous structures of the present invention may comprise a plurality of identical or substantially identical from a compositional perspective fibrous elements according to the present invention. In another example, the fibrous structure may comprise two or more different fibrous elements according to the present invention. Non-limiting examples of differences in the fibrous elements may be physical differences such as differences in diameter, length, texture, shape, rigidness, elasticity, and the like; chemical differences such as crosslinking level, solubility, melting point, Tg, active agent, fibrous element-forming material, color, level of active agent, level of fibrous element-forming material, presence of any coating on fibrous element, biodegradable or not, hydrophobic or not, contact angle, and the like; differences in whether the fibrous element loses its physical structure when the fibrous element is exposed to conditions of intended use; differences in whether the fibrous element's morphology changes when the fibrous element is exposed to conditions of intended use; and differences in rate at which the fibrous element releases one or more of its active agents when the fibrous element is exposed to conditions of intended use. In one example, two or more fibrous elements within the soluble fibrous structure may comprise the same fibrous element-forming material, but have different active agents. This may be the case where the different active agents may be incompatible with one another, for example an anionic surfactant (such as a shampoo active agent) and a cationic surfactant (such as a hair conditioner active agent).

As shown in Fig. 2, a fibrous structure 14 of the present invention may comprise two or more different layers 16, 18 (in the z-direction of the soluble fibrous structure 14) of fibrous elements 10, for example filaments, of the present invention that form the fibrous structure 14. The fibrous elements 10 in layer 16 may be the same as or different from the fibrous elements 10 of layer 18. Each layer 16, 18 may comprise a plurality of identical or substantially identical or different fibrous elements 10. For example, fibrous elements 10 that may release their active agents at a faster rate than others within the fibrous structure 14 may be positioned to an external surface of the fibrous structure 14. In addition to the fibrous elements 10, one or more of the

layers may comprise one or more particles (not shown), for example active agent-containing particles and/or deterrent agent-containing particles dispersed throughout the layers 16, 18 and/or throughout the fibrous structure 14. In addition and/or alternatively, one or more surfaces of the fibrous structure may comprise one or more active agents and/or one or more deterrent agents.

Non-limiting examples of use of the fibrous structure of the present invention include, but are not limited to a laundry dryer substrate, washing machine substrate, washcloth, hard surface cleaning and/or polishing substrate, floor cleaning and/or polishing substrate, as a component in a battery, baby wipe, adult wipe, feminine hygiene wipe, bath tissue wipe, window cleaning substrate, oil containment and/or scavenging substrate, insect repellant substrate, swimming pool chemical substrate, food, breath freshener, deodorant, waste disposal bag, packaging film and/or wrap, wound dressing, medicine delivery, building insulation, crops and/or plant cover and/or bedding, glue substrate, skin care substrate, hair care substrate, air care substrate, water treatment substrate and/or filter, toilet bowl cleaning substrate, candy substrate, pet food, livestock bedding, teeth whitening substrates, carpet cleaning substrates, and other suitable uses of the active agents of the present invention.

The soluble fibrous structures of the present invention may exhibit an average disintegration time of about 60 seconds (s) or less, and/or about 30 s or less, and/or about 10 s or less, and/or about 5 s or less, and/or about 2.0 s or less and/or about 1.5 s or less as measured according to the Dissolution Test Method described herein.

The soluble fibrous structures of the present invention may exhibit an average dissolution time of about 600 seconds (s) or less, and/or about 400 s or less, and/or about 300 s or less, and/or about 200 s or less, and/or about 175 s or less and/or about 100 or less and/or about 50 or less and/or greater than 1 as measured according to the Dissolution Test Method described herein.

The soluble fibrous structures of the present invention may exhibit an average disintegration time per gsm of sample of about 1.0 second/gsm (s/gsm) or less, and/or about 0.5 s/gsm or less, and/or about 0.2 s/gsm or less, and/or about 0.1 s/gsm or less, and/or about 0.05 s/gsm or less, and/or about 0.03 s/gsm or less as measured according to the Dissolution Test Method described herein.

The soluble fibrous structures of the present invention having such fibrous elements may exhibit an average dissolution time per gsm of sample of about 10 seconds/gsm (s/gsm) or less, and/or about 5.0 s/gsm or less, and/or about 3.0 s/gsm or less, and/or about 2.0 s/gsm or less,

and/or about 1.8 s/gsm or less, and/or about 1.5 s/gsm or less as measured according to the Dissolution Test Method described herein.

In one example, the soluble fibrous structure of the present invention exhibits a thickness of greater than 0.01 mm and/or greater than 0.05 mm and/or greater than 0.1 mm and/or to about 20 mm and/or to about 10 mm and/or to about 5 mm and/or to about 2 mm and/or to about 0.5 mm and/or to about 0.3 mm as measured by the Thickness Test Method described herein.

In certain embodiments, suitable fibrous structures can have a water content (% moisture) from 0% to about 20%; in certain embodiments, fibrous structures can have a water content from about 1% to about 15%; and in certain embodiments, fibrous structures can have a water content from about 5% to about 10% as measured according to the Water Content Test Method described herein.

Fibrous Elements

The fibrous element, such as a filament and/or fiber, of the present invention comprises one or more fibrous element-forming materials. In addition to the fibrous element-forming materials, the fibrous element may further comprise one or more active agents present within the fibrous element that are releasable from the fibrous element, for example a filament, such as when the fibrous element and/or soluble fibrous structure comprising the fibrous element is exposed to conditions of intended use. In one example, the total level of the one or more fibrous element-forming materials present in the fibrous element is less than 80% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis and the total level of the one or more active agents present in the fibrous element is greater than 20% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis.

In one example, the fibrous element of the present invention comprises about 100% and/or greater than 95% and/or greater than 90% and/or greater than 85% and/or greater than 75% and/or greater than 50% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of one or more fibrous element-forming materials. For example, the fibrous element-forming material may comprise polyvinyl alcohol, starch, modified starches such as propoxylated starch and/or ethoxylated starch, modified celulluoses such as carboxymethylcellulose and/or hydroxypropylmethyl cellulose, and other suitable polymers, especially hydroxyl polymers.

In another example, the fibrous element of the present invention comprises one or more fibrous element-forming materials and one or more active agents wherein the total level of

fibrous element-forming materials present in the fibrous element is from about 5% to less than 80% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis and the total level of active agents present in the fibrous element is greater than 20% to about 95% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis.

In one example, the fibrous element of the present invention comprises at least 10% and/or at least 15% and/or at least 20% and/or less than less than 80% and/or less than 75% and/or less than 65% and/or less than 60% and/or less than 55% and/or less than 50% and/or less than 45% and/or less than 40% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of the fibrous element-forming materials and greater than 20% and/or at least 35% and/or at least 40% and/or at least 45% and/or at least 50% and/or at least 60% and/or less than 95% and/or less than 90% and/or less than 85% and/or less than 80% and/or less than 75% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of active agents.

In one example, the fibrous element of the present invention comprises at least 5% and/or at least 10% and/or at least 15% and/or at least 20% and/or less than 50% and/or less than 45% and/or less than 40% and/or less than 35% and/or less than 30% and/or less than 25% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of the fibrous element-forming materials and greater than 50% and/or at least 55% and/or at least 60% and/or at least 65% and/or at least 70% and/or less than 95% and/or less than 90% and/or less than 85% and/or less than 80% and/or less than 75% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of active agents. In one example, the fibrous element of the present invention comprises greater than 80% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of active agents.

In another example, the one or more fibrous element-forming materials and active agents are present in the fibrous element at a weight ratio of total level of fibrous element-forming materials to active agents of 4.0 or less and/or 3.5 or less and/or 3.0 or less and/or 2. 5 or less and/or 2.0 or less and/or 1.85 or less and/or less than 1.7 and/or less than 1.6 and/or less than 1.5 and/or less than 1.3 and/or less than 1.2 and/or less than 1 and/or less than 0.7 and/or less than 0.5 and/or less than 0.4 and/or less than 0.3 and/or greater than 0.1 and/or greater than 0.15 and/or greater than 0.2.

In still another example, the fibrous element of the present invention comprises from about 10% and/or from about 15% to less than 80% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of a fibrous element-forming material, such as

polyvinyl alcohol polymer, starch polymer, and/or carboxymethylcellulose polymer, and greater than 20% to about 90% and/or to about 85% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of an active agent. The fibrous element may further comprise a plasticizer, such as glycerin and/or pH adjusting agents, such as citric acid.

In yet another example, the fibrous element of the present invention comprises from about 10% and/or from about 15% to less than 80% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of a fibrous element-forming material, such as polyvinyl alcohol polymer, starch polymer, and/or carboxymethylcellulose polymer, and greater than 20% to about 90% and/or to about 85% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis of an active agent, wherein the weight ratio of fibrous element-forming material to active agent is 4.0 or less. The fibrous element may further comprise a plasticizer, such as glycerin and/or pH adjusting agents, such as citric acid.

In even another example of the present invention, a fibrous element comprises one or more fibrous element-forming materials and one or more active agents selected from the group consisting of: enzymes, bleaching agents, builder, chelants, sensates, dispersants, and mixtures thereof that are releasable and/or released when the fibrous element and/or soluble fibrous structure comprising the fibrous element is exposed to conditions of intended use. In one example, the fibrous element comprises a total level of fibrous element-forming materials of less than 95% and/or less than 90% and/or less than 80% and/or less than 50% and/or less than 35% and/or to about 5% and/or to about 10% and/or to about 20% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis and a total level of active agents selected from the group consisting of: enzymes, bleaching agents, builder, chelants, perfumes, antimicrobials, antibacterials, antifungals, and mixtures thereof of greater than 5% and/or greater than 10% and/or greater than 20% and/or greater than 35% and/or greater than 50% and/or greater than 65% and/or to about 95% and/or to about 90% and/or to about 80% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis. In one example, the active agent comprises one or more enzymes. In another example, the active agent comprises one or more bleaching agents. In yet another example, the active agent comprises one or more builders. In still another example, the active agent comprises one or more chelants. In still another example, the active agent comprises one or more perfumes. In even still another example, the active agent comprises one or more antimicrobials, antibacterials, and/or antifungals.

In yet another example of the present invention, the fibrous elements of the present invention may comprise active agents that may create health and/or safety concerns if they

become airborne. For example, the fibrous element may be used to inhibit enzymes within the fibrous element from becoming airborne.

In one example, the fibrous elements of the present invention may be meltblown fibrous elements. In another example, the fibrous elements of the present invention may be spunbond fibrous elements. In another example, the fibrous elements may be hollow fibrous elements prior to and/or after release of one or more of its active agents.

The fibrous elements of the present invention may be hydrophilic or hydrophobic. The fibrous elements may be surface treated and/or internally treated to change the inherent hydrophilic or hydrophobic properties of the fibrous element.

In one example, the fibrous element exhibits a diameter of less than 100 μm and/or less than 75 μm and/or less than 50 μm and/or less than 25 μm and/or less than 10 μm and/or less than 5 μm and/or less than 1 μm as measured according to the Diameter Test Method described herein. In another example, the fibrous element of the present invention exhibits a diameter of greater than 1 μm as measured according to the Diameter Test Method described herein. The diameter of a fibrous element of the present invention may be used to control the rate of release of one or more active agents present in the fibrous element and/or the rate of loss and/or altering of the fibrous element's physical structure.

The fibrous element may comprise two or more different active agents. In one example, the fibrous element comprises two or more different active agents, wherein the two or more different active agents are compatible with one another. In another example, the fibrous element comprises two or more different active agents, wherein the two or more different active agents are incompatible with one another.

In one example, the fibrous element may comprise an active agent within the fibrous element and an active agent on an external surface of the fibrous element, such as an active agent coating on the fibrous element. The active agent on the external surface of the fibrous element may be the same or different from the active agent present in the fibrous element. If different, the active agents may be compatible or incompatible with one another.

In one example, one or more active agents may be uniformly distributed or substantially uniformly distributed throughout the fibrous element. In another example, one or more active agents may be distributed as discrete regions within the fibrous element. In still another example, at least one active agent is distributed uniformly or substantially uniformly throughout the fibrous element and at least one other active agent is distributed as one or more discrete regions within the fibrous element. In still yet another example, at least one active agent is

distributed as one or more discrete regions within the fibrous element and at least one other active agent is distributed as one or more discrete regions different from the first discrete regions within the fibrous element.

The fibrous structures and/or products of the present invention may also comprise a graphic or indicia which conveys and/or communicates to a user or observer of the fibrous structure and/or product that the fibrous structure and/or product comprises one or more deterrent agents. While it is important for the fibrous structure and/or product simply to comprise one or more deterrent agents, a visual signal which communicates the presence of and/or is previously associated with the one or more deterrent agents may assist in further achievement of the goal of mitigating the risk of accidental ingestion by humans. Alternatively, the graphic or indicia itself might comprise both the visual signal graphic and the one or more deterrent agents. Further non-limiting examples of fibrous structures and/or products that include graphics and/or indicia is found in U.S. Patent Application No. 14/558,829 filed Dec. 3, 2014.

The term "graphic" or "indicia" refers to images or designs that may be constituted by a figure (e.g., a line(s)), a symbol or character, a single color symbol or character, a color difference or transition of at least two colors, a multiple color symbol or character, or the like. A graphic may include an aesthetic image or design that can provide certain benefit(s) when viewed. A graphic may be in the form of a photographic image. A graphic may also be in the form of a 1-dimensional (1-D) or 2-dimensional (2-D) bar code or a quick response (QR) bar code. A graphic design is determined by, for example, the color(s) used in the graphic (individual pure ink or spot colors as well as built process colors), the sizes of the entire graphic (or components of the graphic), the positions of the graphic (or components of the graphic), the movements of the graphic (or components of the graphic), the geometrical shapes of the graphic (or components of the graphics), the number of colors in the graphic, the variations of the color combinations in the graphic, the number of graphics printed, the disappearance of color(s) in the graphic, and the contents of text messages in the graphic.

Fibrous Element-forming Material

The fibrous element-forming material is any suitable material, such as a polymer or monomers capable of producing a polymer that exhibits properties suitable for making a fibrous element, such as by a spinning process.

In one example, the fibrous element-forming material may comprise a polar solvent-soluble material, such as an alcohol-soluble material and/or a water-soluble material.

In another example, the fibrous element-forming material may comprise a non-polar solvent-soluble material.

In still another example, the filament forming material may comprise a polar solvent-soluble material and be free (less than 5% and/or less than 3% and/or less than 1% and/or 0% by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis) of non-polar solvent-soluble materials.

In yet another example, the fibrous element-forming material may be a film-forming material. In still yet another example, the fibrous element-forming material may be synthetic or of natural origin and it may be chemically, enzymatically, and/or physically modified.

In even another example of the present invention, the fibrous element-forming material may comprise a polymer selected from the group consisting of: polymers derived from acrylic monomers such as the ethylenically unsaturated carboxylic monomers and ethylenically unsaturated monomers, polyvinyl alcohol, polyacrylates, polymethacrylates, copolymers of acrylic acid and methyl acrylate, polyvinylpyrrolidones, polyalkylene oxides, starch and starch derivatives, pullulan, gelatin, hydroxypropylmethylcelluloses, methycelluloses, and carboxymethycelluloses.

In still another example, the fibrous element-forming material may comprises a polymer selected from the group consisting of: polyvinyl alcohol, polyvinyl alcohol derivatives, starch, starch derivatives, cellulose derivatives, hemicellulose, hemicellulose derivatives, proteins, sodium alginate, hydroxypropyl methylcellulose, chitosan, chitosan derivatives, polyethylene glycol, tetramethylene ether glycol, polyvinyl pyrrolidone, hydroxymethyl cellulose, hydroxyethyl cellulose, and mixtures thereof.

In another example, the fibrous element-forming material comprises a polymer is selected from the group consisting of: pullulan, hydroxypropylmethyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, polyvinyl pyrrolidone, carboxymethyl cellulose, sodium alginate, xanthan gum, tragacanth gum, guar gum, acacia gum, Arabic gum, polyacrylic acid, methylmethacrylate copolymer, carboxyvinyl polymer, dextrin, pectin, chitin, levan, elsinan, collagen, gelatin, zein, gluten, soy protein, casein, polyvinyl alcohol, starch, starch derivatives, hemicellulose, hemicellulose derivatives, proteins, chitosan, chitosan derivatives, polyethylene glycol, tetramethylene ether glycol, hydroxymethyl cellulose, and mixtures thereof.

Polar Solvent-soluble Materials

Non-limiting examples of polar solvent-soluble materials include polar solvent-soluble polymers. The polar solvent-soluble polymers may be synthetic or natural original and may be chemically and/or physically modified. In one example, the polar solvent-soluble polymers exhibit a weight average molecular weight of at least 10,000 g/mol and/or at least 20,000 g/mol and/or at least 40,000 g/mol and/or at least 80,000 g/mol and/or at least 100,000 g/mol and/or at least 1,000,000 g/mol and/or at least 3,000,000 g/mol and/or at least 10,000,000 g/mol and/or at least 20,000,000 g/mol and/or to about 40,000,000 g/mol and/or to about 30,000,000 g/mol.

In one example, the polar solvent-soluble polymers are selected from the group consisting of: alcohol-soluble polymers, water-soluble polymers and mixtures thereof. Non-limiting examples of water-soluble polymers include water-soluble hydroxyl polymers, water-soluble thermoplastic polymers, water-soluble biodegradable polymers, water-soluble non-biodegradable polymers and mixtures thereof. In one example, the water-soluble polymer comprises polyvinyl alcohol. In another example, the water-soluble polymer comprises starch. In yet another example, the water-soluble polymer comprises polyvinyl alcohol and starch.

a. Water-soluble Hydroxyl Polymers - Non-limiting examples of water-soluble hydroxyl polymers in accordance with the present invention include polyols, such as polyvinyl alcohol, polyvinyl alcohol derivatives, polyvinyl alcohol copolymers, starch, starch derivatives, starch copolymers, chitosan, chitosan derivatives, chitosan copolymers, cellulose derivatives such as cellulose ether and ester derivatives, cellulose copolymers, hemicellulose, hemicellulose derivatives, hemicellulose copolymers, gums, arabinans, galactans, proteins and various other polysaccharides and mixtures thereof.

In one example, a water-soluble hydroxyl polymer of the present invention comprises a polysaccharide.

"Polysaccharides" as used herein means natural polysaccharides and polysaccharide derivatives and/or modified polysaccharides. Suitable water-soluble polysaccharides include, but are not limited to, starches, starch derivatives, chitosan, chitosan derivatives, cellulose derivatives, hemicellulose, hemicellulose derivatives, gums, arabinans, galactans and mixtures thereof. The water-soluble polysaccharide may exhibit a weight average molecular weight of from about 10,000 to about 40,000,000 g/mol and/or greater than 100,000 g/mol and/or greater than 1,000,000 g/mol and/or greater than 3,000,000 g/mol and/or greater than 3,000,000 to about 40,000,000 g/mol.

The water-soluble polysaccharides may comprise non-cellulose and/or non-cellulose derivative and/or non-cellulose copolymer water-soluble polysaccharides. Such non-cellulose water-soluble polysaccharides may be selected from the group consisting of: starches, starch derivatives, chitosan, chitosan derivatives, hemicellulose, hemicellulose derivatives, gums, arabinans, galactans and mixtures thereof.

In another example, a water-soluble hydroxyl polymer of the present invention comprises a non-thermoplastic polymer.

The water-soluble hydroxyl polymer may have a weight average molecular weight of from about 10,000 g/mol to about 40,000,000 g/mol and/or greater than 100,000 g/mol and/or greater than 1,000,000 g/mol and/or greater than 3,000,000 g/mol and/or greater than 3,000,000 g/mol to about 40,000,000 g/mol. Higher and lower molecular weight water-soluble hydroxyl polymers may be used in combination with hydroxyl polymers having a certain desired weight average molecular weight.

Well known modifications of water-soluble hydroxyl polymers, such as natural starches, include chemical modifications and/or enzymatic modifications. For example, natural starch can be acid-thinned, hydroxy-ethylated, hydroxy-propylated, and/or oxidized. In addition, the water-soluble hydroxyl polymer may comprise dent corn starch.

Naturally occurring starch is generally a mixture of linear amylose and branched amylopectin polymer of D-glucose units. The amylose is a substantially linear polymer of D-glucose units joined by (1,4)-α-D links. The amylopectin is a highly branched polymer of D-glucose units joined by (1,4)-α-D links and (1,6)-α-D links at the branch points. Naturally occurring starch typically contains relatively high levels of amylopectin, for example, corn starch (64-80% amylopectin), waxy maize (93-100% amylopectin), rice (83-84% amylopectin), potato (about 78% amylopectin), and wheat (73-83% amylopectin). Though all starches are potentially useful herein, the present invention is most commonly practiced with high amylopectin natural starches derived from agricultural sources, which offer the advantages of being abundant in supply, easily replenishable and inexpensive.

As used herein, "starch" includes any naturally occurring unmodified starches, modified starches, synthetic starches and mixtures thereof, as well as mixtures of the amylose or amylopectin fractions; the starch may be modified by physical, chemical, or biological processes, or combinations thereof. The choice of unmodified or modified starch for the present invention may depend on the end product desired. In one embodiment of the present invention, the starch or starch mixture useful in the present invention has an amylopectin content from about 20% to

about 100%, more typically from about 40% to about 90%, even more typically from about 60% to about 85% by weight of the starch or mixtures thereof.

Suitable naturally occurring starches can include, but are not limited to, corn starch, potato starch, sweet potato starch, wheat starch, sago palm starch, tapioca starch, rice starch, soybean starch, arrow root starch, amioca starch, bracken starch, lotus starch, waxy maize starch, and high amylose corn starch. Naturally occurring starches particularly, corn starch and wheat starch, are the preferred starch polymers due to their economy and availability.

Polyvinyl alcohols herein can be grafted with other monomers to modify its properties. A wide range of monomers has been successfully grafted to polyvinyl alcohol. Non-limiting examples of such monomers include vinyl acetate, styrene, acrylamide, acrylic acid, 2-hydroxyethyl methacrylate, acrylonitrile, 1,3-butadiene, methyl methacrylate, methacrylic acid, maleic acid, itaconic acid, sodium vinylsulfonate, sodium allylsulfonate, sodium methylallyl sulfonate, sodium phenylallylether sulfonate, sodium phenylmethallylether sulfonate, 2-acrylamido-methyl propane sulfonic acid (AMPs), vinylidene chloride, vinyl chloride, vinyl amine and a variety of acrylate esters.

In one example, the water-soluble hydroxyl polymer is selected from the group consisting of: polyvinyl alcohols, hydroxymethylcelluloses, hydroxyethylcelluloses, hydroxypropylmethylcelluloses and mixtures thereof. A non-limiting example of a suitable polyvinyl alcohol includes those commercially available from Sekisui Specialty Chemicals America, LLC (Dallas, TX) under the CELVOL® trade name. A non-limiting example of a suitable hydroxypropylmethylcellulose includes those commercially available from the Dow Chemical Company (Midland, MI) under the METHOCEL® trade name including combinations with above mentioned hydroxypropylmethylcelluloses.

b. Water-soluble Thermoplastic Polymers - Non-limiting examples of suitable water-soluble thermoplastic polymers include thermoplastic starch and/or starch derivatives, polylactic acid, polyhydroxyalkanoate, polycaprolactone, polyesteramides and certain polyesters, and mixtures thereof.

The water-soluble thermoplastic polymers of the present invention may be hydrophilic or hydrophobic. The water-soluble thermoplastic polymers may be surface treated and/or internally treated to change the inherent hydrophilic or hydrophobic properties of the thermoplastic polymer.

The water-soluble thermoplastic polymers may comprise biodegradable polymers.

Any suitable weight average molecular weight for the thermoplastic polymers may be used. For example, the weight average molecular weight for a thermoplastic polymer in accordance with the present invention is greater than about 10,000 g/mol and/or greater than about 40,000 g/mol and/or greater than about 50,000 g/mol and/or less than about 500,000 g/mol and/or less than about 400,000 g/mol and/or less than about 200,000 g/mol.

Non-polar Solvent-soluble Materials

Non-limiting examples of non-polar solvent-soluble materials include non-polar solvent-soluble polymers. Non-limiting examples of suitable non-polar solvent-soluble materials include cellulose, chitin, chitin derivatives, polyolefins, polyesters, copolymers thereof, and mixtures thereof. Non-limiting examples of polyolefins include polypropylene, polyethylene and mixtures thereof. A non-limiting example of a polyester includes polyethylene terephthalate.

The non-polar solvent-soluble materials may comprise a non-biodegradable polymer such as polypropylene, polyethylene and certain polyesters.

Any suitable weight average molecular weight for the thermoplastic polymers may be used. For example, the weight average molecular weight for a thermoplastic polymer in accordance with the present invention is greater than about 10,000 g/mol and/or greater than about 40,000 g/mol and/or greater than about 50,000 g/mol and/or less than about 500,000 g/mol and/or less than about 400,000 g/mol and/or less than about 200,000 g/mol.

Active Agents

Active agents are a class of additives that are designed and intended to provide a benefit to something other than the fibrous element and/or particle and/or soluble fibrous structure itself, such as providing a benefit to an environment external to the fibrous element and/or particle and/or soluble fibrous structure. Active agents may be any suitable additive that produces an intended effect under intended use conditions of the fibrous element. For example, the active agent may be selected from the group consisting of: personal cleansing and/or conditioning agents such as hair care agents such as shampoo agents and/or hair colorant agents, hair conditioning agents, skin care agents, sunscreen agents, and skin conditioning agents; laundry care and/or conditioning agents such as fabric care agents, fabric conditioning agents, fabric softening agents, fabric anti-wrinkling agents, fabric care anti-static agents, fabric care stain removal agents, soil release agents, dispersing agents, suds suppressing agents, suds boosting agents, anti-foam agents, and fabric refreshing agents; liquid and/or powder dishwashing agents

(for hand dishwashing and/or automatic dishwashing machine applications), hard surface care agents, and/or conditioning agents and/or polishing agents; other cleaning and/or conditioning agents such as antimicrobial agents, antibacterial agents, antifungal agents, fabric hueing agents, perfume, bleaching agents (such as oxygen bleaching agents, hydrogen peroxide, percarbonate bleaching agents, perborate bleaching agents, chlorine bleaching agents), bleach activating agents, chelating agents, builders, lotions, brightening agents, air care agents, carpet care agents, dye transfer-inhibiting agents, clay soil removing agents, anti-redeposition agents, polymeric soil release agents, polymeric dispersing agents, alkoxylated polyamine polymers, alkoxylated polycarboxylate polymers, amphilic graft copolymers, dissolution aids, buffering systems, water-softening agents, water-hardening agents, pH adjusting agents, enzymes, flocculating agents, effervescent agents, preservatives, cosmetic agents, make-up removal agents, lathering agents, deposition aid agents, coacervate-forming agents, clays, thickening agents, latexes, silicas, drying agents, odor control agents, antiperspirant agents, cooling agents, warming agents, absorbent gel agents, anti-inflammatory agents, dyes, pigments, acids, and bases; liquid treatment active agents; agricultural active agents; industrial active agents; ingestible active agents such as medicinal agents, teeth whitening agents, tooth care agents, mouthwash agents, periodontal gum care agents, edible agents, dietary agents, vitamins, minerals; water-treatment agents such as water clarifying and/or water disinfecting agents, and mixtures thereof.

Non-limiting examples of suitable cosmetic agents, skin care agents, skin conditioning agents, hair care agents, and hair conditioning agents are described in CTFA Cosmetic Ingredient Handbook, Second Edition, The Cosmetic, Toiletries, and Fragrance Association, Inc. 1988, 1992.

One or more classes of chemicals may be useful for one or more of the active agents listed above. For example, surfactants may be used for any number of the active agents described above. Likewise, bleaching agents may be used for fabric care, hard surface cleaning, dishwashing and even teeth whitening. Therefore, one of ordinary skill in the art will appreciate that the active agents will be selected based upon the desired intended use of the fibrous element and/or particle and/or soluble fibrous structure made therefrom.

For example, if the fibrous element and/or particle and/or soluble fibrous structure made therefrom is to be used for hair care and/or conditioning then one or more suitable surfactants, such as a lathering surfactant could be selected to provide the desired benefit to a consumer when exposed to conditions of intended use of the fibrous element and/or particle and/or soluble fibrous structure incorporating the fibrous element and/or particle.

In one example, if the fibrous element and/or particle and/or soluble fibrous structure made therefrom is designed or intended to be used for laundering clothes in a laundry operation, then one or more suitable surfactants and/or enzymes and/or builders and/or perfumes and/or suds suppressors and/or bleaching agents could be selected to provide the desired benefit to a consumer when exposed to conditions of intended use of the fibrous element and/or particle and/or soluble fibrous structure incorporating the fibrous element and/or particle. In another example, if the fibrous element and/or particle and/or soluble fibrous structure made therefrom is designed to be used for laundering clothes in a laundry operation and/or cleaning dishes in a dishwashing operation, then the fibrous element and/or particle and/or soluble fibrous structure may comprise a laundry detergent composition or dishwashing detergent composition or active agents used in such compositions. In still another example, if the fibrous element and/or particle and/or soluble fibrous structure made therefrom is designed to be used for cleaning and/or sanitizing a toilet bowl, then the fibrous element and/or particle and/or soluble fibrous structure made therefrom may comprise a toilet bowl cleaning composition and/or effervescent composition and/or active agents used in such compositions.

In one example, the active agent is selected from the group consisting of: surfactants, bleaching agents, enzymes, suds suppressors, suds boosting agents, fabric softening agents, denture cleaning agents, hair cleaning agents, hair care agents, personal health care agents, hueing agents, and mixtures thereof.

In one example, at least one of the active agents is selected from the group consisting of: skin benefit agents, medicinal agents, lotions, fabric care agents, dishwashing agents, carpet care agents, surface care agents, hair care agents, air care agents, and mixtures thereof.

Release of Active Agent

One or more active agents may be released from the fibrous element and/or particle and/or fibrous structure when the fibrous element and/or particle and/or fibrous structure are exposed to a triggering condition. In one example, one or more active agents may be released from the fibrous element and/or particle and/or fibrous structure or a part thereof when the fibrous element and/or particle and/or fibrous structure or the part thereof loses its identity, in other words, loses its physical structure. For example, a fibrous element and/or particle and/or fibrous structure loses its physical structure when the fibrous element-forming material dissolves, melts or undergoes some other transformative step such that its structure is lost. In one example, the one or more active agents are released from the fibrous element and/or particle and/or fibrous

structure when the fibrous element's and/or particle's and/or fibrous structure's morphology changes.

In another example, one or more active agents may be released from the fibrous element and/or particle and/or fibrous structure or a part thereof when the fibrous element and/or particle and/or fibrous structure or the part thereof alters its identity, in other words, alters its physical structure rather than loses its physical structure. For example, a fibrous element and/or particle and/or fibrous structure alters its physical structure when the fibrous element-forming material swells, shrinks, lengthens, and/or shortens, but retains its fibrous element-forming properties.

In another example, one or more active agents may be released from the fibrous element and/or particle and/or fibrous structure with its morphology not changing (not losing or altering its physical structure).

In one example, the fibrous element and/or particle and/or fibrous structure may release an active agent upon the fibrous element and/or particle and/or fibrous structure being exposed to a triggering condition that results in the release of the active agent, such as by causing the fibrous element and/or particle and/or fibrous structure to lose or alter its identity as discussed above. Non-limiting examples of triggering conditions include exposing the fibrous element and/or particle and/or fibrous structure to solvent, a polar solvent, such as alcohol and/or water, and/or a non-polar solvent, which may be sequential, depending upon whether the fibrous element-forming material comprises a polar solvent-soluble material and/or a non-polar solvent-soluble material; exposing the fibrous element and/or particle and/or soluble fibrous structure to heat, such as to a temperature of greater than 75°F and/or greater than 100°F and/or greater than 150°F and/or greater than 200°F and/or greater than 212°F; exposing the fibrous element and/or particle and/or soluble fibrous structure to cold, such as to a temperature of less than 40°F and/or less than 32°F and/or less than 0°F; exposing the fibrous element and/or particle and/or soluble fibrous structure to a force, such as a stretching force applied by a consumer using the fibrous element and/or particle and/or fibrous structure; and/or exposing the fibrous element and/or particle and/or fibrous structure to a chemical reaction; exposing the fibrous element and/or particle and/or fibrous structure to a condition that results in a phase change; exposing the fibrous element and/or particle and/or fibrous structure to a pH change and/or a pressure change and/or temperature change; exposing the fibrous element and/or particle and/or fibrous structure to one or more chemicals that result in the fibrous element and/or particle and/or fibrous structure releasing one or more of its active agents; exposing the fibrous element and/or particle and/or fibrous structure to ultrasonics; exposing the fibrous element and/or particle and/or fibrous

structure to light and/or certain wavelengths; exposing the fibrous element and/or particle and/or fibrous structure to a different ionic strength; and/or exposing the fibrous element and/or particle and/or fibrous structure to an active agent released from another fibrous element and/or particle and/or fibrous structure.

In one example, one or more active agents may be released from the fibrous elements and/or particles of the present invention when a fibrous structure comprising the fibrous elements and/or particles is subjected to a triggering step selected from the group consisting of: pre-treating stains on a fabric article with the fibrous structure; forming a wash liquor by contacting the fibrous structure with water; tumbling the soluble fibrous structure in a dryer; heating the fibrous structure in a dryer; and combinations thereof.

Fibrous Element-forming Composition

The fibrous elements of the present invention are made from a fibrous element-forming composition. The fibrous element-forming composition is a polar-solvent-based composition. In one example, the fibrous element-forming composition is an aqueous composition comprising one or more fibrous element-forming materials and one or more active agents.

Even though the fibrous element and/or fibrous structure of the present invention are in solid form, the fibrous element-forming composition used to make the fibrous elements of the present invention may be in the form of a liquid.

The fibrous element-forming composition may be processed at a temperature of from about 20°C to about 100°C and/or from about 30°C to about 90°C and/or from about 35°C to about 70°C and/or from about 40°C to about 60°C when making fibrous elements from the fibrous element-forming composition.

In one example, the fibrous element-forming composition may comprise at least 20% and/or at least 30% and/or at least 40% and/or at least 45% and/or at least 50% to about 90% and/or to about 85% and/or to about 80% and/or to about 75% by weight of one or more fibrous element-forming materials, one or more active agents, and mixtures thereof. The fibrous element-forming composition may comprise from about 10% to about 80% by weight of a polar solvent, such as water.

In one example, non-volatile components of the fibrous element-forming composition may comprise from about 20% and/or 30% and/or 40% and/or 45% and/or 50% to about 75% and/or 80% and/or 85% and/or 90% by weight based on the total weight of the fibrous element-forming composition. The non-volatile components may be composed of fibrous element-

forming materials, such as backbone polymers, active agents and combinations thereof. Volatile components of the fibrous element-forming composition will comprise the remaining percentage and range from 10% to 80% by weight based on the total weight of the fibrous element-forming composition.

In a fibrous element spinning process, the fibrous elements need to have initial stability as they leave the spinning die. Capillary Number is used to characterize this initial stability criterion. At the conditions of the die, the Capillary Number may be at least 1 and/or at least 3 and/or at least 4 and/or at least 5.

In one example, the fibrous element-forming composition exhibits a Capillary Number of from at least about 1 to about 50 and/or at least about 3 to about 50 and/or at least about 5 to about 30 such that the fibrous element-forming composition can be effectively polymer processed into a fibrous element.

"Polymer processing" as used herein means any spinning operation and/or spinning process by which a fibrous element comprising a processed fibrous element-forming material is formed from a fibrous element-forming composition. The spinning operation and/or process may include spun bonding, melt blowing, electro-spinning, rotary spinning, continuous filament producing and/or tow fiber producing operations/processes. A "processed fibrous element-forming material" as used herein means any fibrous element-forming material that has undergone a melt processing operation and a subsequent polymer processing operation resulting in a fibrous element.

The Capillary Number is a dimensionless number used to characterize the likelihood of this droplet breakup. A larger Capillary Number indicates greater fluid stability upon exiting the die. The Capillary Number is defined as follows:

$$Ca = \frac{V * \eta}{\sigma}$$

V is the fluid velocity at the die exit (units of Length per Time),

η is the fluid viscosity at the conditions of the die (units of Mass per Length*Time),

σ is the surface tension of the fluid (units of mass per Time^2). When velocity, viscosity, and surface tension are expressed in a set of consistent units, the resulting Capillary Number will have no units of its own; the individual units will cancel out.

The Capillary Number is defined for the conditions at the exit of the die. The fluid velocity is the average velocity of the fluid passing through the die opening. The average velocity is defined as follows:

$$V = \frac{Vol'}{Area}$$

Vol′ = volumetric flowrate (units of Length^3 per Time),

Area = cross-sectional area of the die exit (units of Length^2).

When the die opening is a circular hole, then the fluid velocity can be defined as

$$V = \frac{Vol'}{\pi * R^2}$$

R is the radius of the circular hole (units of length).

The fluid viscosity will depend on the temperature and may depend of the shear rate. The definition of a shear thinning fluid includes a dependence on the shear rate. The surface tension will depend on the makeup of the fluid and the temperature of the fluid.

In one example, the fibrous element-forming composition may comprise one or more release agents and/or lubricants. Non-limiting examples of suitable release agents and/or lubricants include fatty acids, fatty acid salts, fatty alcohols, fatty esters, sulfonated fatty acid esters, fatty amine acetates and fatty amides, silicones, aminosilicones, fluoropolymers and mixtures thereof.

In one example, the fibrous element-forming composition may comprise one or more antiblocking and/or detackifying agents. Non-limiting examples of suitable antiblocking and/or detackifying agents include starches, modified starches, crosslinked polyvinylpyrrolidone, crosslinked cellulose, microcrystalline cellulose, silica, metallic oxides, calcium carbonate, talc and mica.

Active agents of the present invention may be added to the fibrous element-forming composition prior to and/or during fibrous element formation and/or may be added to the fibrous element after fibrous element formation. For example, a perfume active agent may be applied to the fibrous element and/or soluble fibrous structure comprising the fibrous element after the fibrous element and/or soluble fibrous structure according to the present invention are formed. In another example, an enzyme active agent may be applied to the fibrous element and/or soluble fibrous structure comprising the fibrous element after the fibrous element and/or soluble fibrous structure according to the present invention are formed. In still another example, one or more particles, which may not be suitable for passing through the spinning process for making the fibrous element, may be applied to the fibrous element and/or soluble fibrous structure comprising the fibrous element after the fibrous element and/or soluble fibrous structure according to the present invention are formed.

In one example, the fibrous element-forming composition of the present invention exhibits a Viscosity Value of less than about 100 Pa·s and/or less than about 80 Pa·s and/or less than about 60 Pa·s and/or less than about 40 Pa·s and/or less than about 20 Pa·s and/or less than about 10 Pa·s and/or less than about 5 Pa·s and/or less than about 2 Pa·s and/or less than about 1 Pa·s and/or greater than 0 Pa·s as measured according to the Viscosity Value Test Method described herein.

Extensional Aids

In one example, the fibrous element comprises an extensional aid. Non-limiting examples of extensional aids can include polymers, other extensional aids, and combinations thereof.

In one example, the extensional aids have a weight-average molecular weight of at least about 50,000 Da. In another example, the weight average molecular weight of the extensional aid is from about 50,000 to about 25,000,000 and/or from about 100,000 to about 25,000,000 and/or from about 250,000 to about 25,000,000 and/or from about 500,000 to about 25,000,000, in another example from about 800,000 to about 22,000,000, in yet another example from about 1,000,000 to about 20,000,000, and in another example from about 2,000,000 to about 15,000,000. The high molecular weight extensional aids are especially suitable in some examples of the invention due to the ability to increase extensional melt viscosity and reducing melt fracture.

The extensional aid, when used in a meltblowing process, is added to the composition of the present invention in an amount effective to visibly reduce the melt fracture and capillary breakage of fibers during the spinning process such that substantially continuous fibers having relatively consistent diameter can be melt spun. Regardless of the process employed to produce fibrous elements and/or particles, the extensional aids, when used, can be present from about 0.001% to about 10%, by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis, in one example, and in another example from about 0.005 to about 5%, by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis, in yet another example from about 0.01 to about 1%, by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis, and in another example from about 0.05% to about 0.5%, by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis.

Non-limiting examples of polymers that can be used as extensional aids can include alginates, carrageenans, pectin, chitin, guar gum, xanthum gum, agar, gum arabic, karaya gum, tragacanth gum, locust bean gum, alkylcellulose, hydroxyalkylcellulose, carboxyalkylcellulose, and mixtures thereof.

Non-limiting examples of other extensional aids can include modified and unmodified polyacrylamide, polyacrylic acid, polymethacrylic acid, polyvinyl alcohol, polyvinylacetate, polyvinylpyrrolidone, polyethylene vinyl acetate, polyethyleneimine, polyamides, polyalkylene oxides including polyethylene oxide, polypropylene oxide, polyethylenepropylene oxide, and mixtures thereof.

Dissolution Aids

The fibrous elements of the present invention may incorporate dissolution aids to accelerate dissolution when the fibrous element contains more than 40% surfactant to mitigate formation of insoluble or poorly soluble surfactant aggregates that can sometimes form or when the surfactant compositions are used in cold water. Non-limiting examples of dissolution aids include sodium chloride, sodium sulfate, potassium chloride, potassium sulfate, magnesium chloride, and magnesium sulfate.

Buffer System

The fibrous elements of the present invention may be formulated such that, during use in an aqueous cleaning operation, for example washing clothes or dishes and/or washing hair, the wash water will have a pH of between about 5.0 and about 12 and/or between about 7.0 and 10.5. In the case of a dishwashing operation, the pH of the wash water typically is between about 6.8 and about 9.0. In the case of washing clothes, the pH of the was water typically is between 7 and 11. Techniques for controlling pH at recommended usage levels include the use of buffers, alkalis, acids, etc., and are well known to those skilled in the art. These include the use of sodium carbonate, citric acid or sodium citrate, monoethanol amine or other amines, boric acid or borates, and other pH-adjusting compounds well known in the art.

Fibrous elements and/or soluble fibrous structures useful as "low pH" detergent compositions are included in the present invention and are especially suitable for the surfactant systems of the present invention and may provide in-use pH values of less than 8.5 and/or less than 8.0 and/or less than 7.0 and/or less than 7.0 and/or less than 5.5 and/or to about 5.0.

Dynamic in-wash pH profile fibrous elements are included in the present invention. Such fibrous elements may use wax-covered citric acid particles in conjunction with other pH control agents such that (i) 3 minutes after contact with water, the pH of the wash liquor is greater than 10; (ii) 10mins after contact with water, the pH of the wash liquor is less than 9.5; (iii) 20mins after contact with water, the pH of the wash liquor is less than 9.0; and (iv) optionally, wherein, the equilibrium pH of the wash liquor is in the range of from above 7.0 to 8.5.

Deterrent Agent

One or more fibrous elements and/or fibrous structures of the present invention further comprises one or more deterrent agents; namely, an agent that is intended to discourage ingestion and/or consuming, for example via bitter taste and/or pungent taste and/or pungent smell, of the fibrous elements and/or fibrous structures and/or products comprising the same of the present invention and/or that cause humans and/or animals to vomit, for example via emetic agents. Non-limiting examples of suitable deterrent agents for use in and/or on and/or within one or more of the fibrous elements and/or fibrous structures and/or products made therefrom, such as pads, of the present invention include bittering agents, pungent agents, emetic agents, and mixtures thereof.

In one example the total level of deterrent agents associated with, for example present in and/or on, the fibrous elements, fibrous structures and/or products of the present invention may be at least a level that causes the desired deterrent effect and may depend on the characteristics of the specific deterrent agents, for example bitter value, but not a level that can cause undesired transfer of the deterrent agents to a human and/or animal, such as transfer to hands, eyes, skin, or other parts of a human and/or animal. In another example, an effective amount of a deterrent agent within and/or on a fibrous element and/or fibrous structure and/or product may be based on the particular deterrent agent's potency such that greater than 50% of humans experience a deterrent effect when exposed to the deterrent agent.

a. Bittering Agents

Non-limiting examples of suitable bittering agents include denatonium salts and derivatives thereof. In one example, the bittering agent is a denatonium salt selected from the group consisting of denatonium chloride, denatonium citrate, denatonium saccharide, denatonium carbonate, denatonium acetate, denatonium benzoate, and mixtures thereof. The bittering agent

may be present in and/or on one or more fibrous elements and/or fibrous structures of the present invention.

In one example, the bittering agent is denatonium benzoate, also known as phenylmethyl-[2- [(2,6-dimethylphenyl)amino]- 2-oxoethyl]-diethylammonium benzoate, CAS no. 3734-33-6. Denatonium benzoate is commercially sold as BITREX®, available from Macfarlan Smith, Edinburgh, Scotland, UK.

The bittering agent may be a natural bitter substance. The bittering agent, for example a natural bitter substance, may exhibit a bitter value of greater than 1,000 and/or greater than 5,000 and/or greater than 10,000 and/or greater than 20,000 and/or less than 200,000 and/or less than 150,000 and/or less than 100,000 and/or from about 1,000 to about 200,000 and/or from about 5,000 to about 200,000 and/or from about 10,000 to about 200,000. The natural bitter substance may be selected from the group consisting of glycosides, isoprenoids, alkaloids, amino acids, and mixtures thereof. For example, suitable bittering agents also include Quercetin (3,3',4',5,7-pentahydroxyflavone); Naringin (4',5,7-Trihydroxyflavanone-7-rhamnoglucoside); Aucubin; Amarogentin; Dihydrofoliamentin; Gentiopicroside; Gentiopicrin; Swertiamarin; Swerosid; Gentioflavosid; Centaurosid; Methiafolin; Harpagoside; Centapikrin; Sailicin; Kondurangin; Absinthin; Artabsin; Cnicin; Lactucin; Lactucopicrin; Salonitenolid; α-thujone; ß-thujone; Desoxy Limonene; Limonin; Ichangin; iso-Obacunoic Acid; Obacunone; Obacunoic Acid; Nomilin; Ichangin; Nomilinoic acid; Marrubin; Prämarrubin; Carnosol; Carnosic acid; Quassin; Brucine; Quinine hydrochloride; Quinine sulfate; Quinine dihydrochloride; Columbine; Caffeine; Threonine; Methionine; Phenylalanine; Tryptophan; Arginine; Histidine; Valine; Aspartic acid; Sucrose octaacetate; and mixtures thereof. Other suitable bittering agents include quinine bisulfate and hop extract (e.g., humulone).

The fibrous element and/or fibrous structure and/or product comprising the same may comprise a sufficient amount of the bittering agent to provide a bitter taste, for example from about 0.00001% to about 1% and/or from about 0.0001% to about 0.5% and/or from about 0.001% to about 0.25% and/or from about 0.01% to about 0.1% by weight of the fibrous element and/or fibrous structure and/or product, respectively, of the bittering agent.

The bittering agent or parts thereof associated with a fibrous element and/or fibrous structure and/or product comprising the same may be present on a surface of the fibrous element and/or fibrous structure and/or product comprising the same. The bittering agent may migrate from within a fibrous element and/or fibrous structure and/or product comprising the same to an exterior surface thereof such that a human or animal experiences a bitter taste from the fibrous

element and/or fibrous structure and/or product upon contact with their mouth. In addition to and/or alternatively, the bittering agent may be applied to a surface of the fibrous element and/or fibrous structure and/or product comprising the same after the fibrous element and/or fibrous structure and/or product have been formed, such as in the way of a coating composition comprising the bittering agent, for example by spraying and/or printing and/or atomizing and/or dusting and/or powdering and/or coating and/or painting and/or otherwise depositing the bittering agent and/or composition comprising the bitter agent directly onto a surface of the fibrous element and/or fibrous structure and/or product. In one example, the bittering agent is present in and/or on the surface of the fibrous element and/or fibrous structure and/or product comprising the same at a level of at least 10ppb and/or at least 50ppb and/or from about 10 ppb to about 10,000ppm and/or from about 50ppb to about 5,000ppm and/or from about 50ppb to about 1,000ppm and/or from about 100ppb to about 500ppm and/or from about 10ppm to about 250ppm as determined after storage of the fibrous element and/or fibrous structure and/or product for one month 25°C and 60% relative humidity.

When the bittering agent and/or composition comprising the bittering agent is sprayed and/or printed and/or atomized and/or otherwise deposited onto a surface of the fibrous element and/or fibrous structure and/or product, the bittering agent and/or composition comprising the bittering agent may be non-aqueous, meaning that it comprises less than 20% and/or less than 15% and/or less than 10% and/or less than 5% and/or less than 3% and/or less than 1% and/or about 0% and/or 0% by weight water. The composition comprising the bittering agent may comprise 100% and/or 80% and/or 60% and/or 40% and/or 35% and/or 30% and/or greater than 0% to about 100% and/or from about 0.001% to about 80% and/or from about 0.001% to about 60% and/or from about 0.001% to about 40% and/or from about 0.1% to about 35% and/or from about 5% to about 30% by weight of the bittering agent.

Non-limiting examples of suitable bittering agents for use in the present invention are described at BitterDB (http://bitterdb.agri.huji.ac.il/dbbitter.php), which is a free searchable database of bittering agents that holds over 680 bittering agents obtained from literature and the Merck Index and their associated 25 human bitter taste receptors (hT2Rs), and in the corresponding paper Ayana Wiener; Marina Shudler; Anat Levit; Masha Y. Niv. BitterDB: a database of bitter compounds. *Nucleic Acids Res 2012, 40(Database issue):D413-419.*

In addition to the above, one or more bittering agents may be present in and/or on a surface of the fibrous elements and/or fibrous structures and/or products of the present invention at a level of from about 0.01 ppm to about 10% and/or from about 0.01 ppm to about 8% and/or

from about 0.01 ppm to about 5% and/or 0.01 ppm to about 4% by weight of the fibrous element and/or fibrous structure and/or product.

b. Pungent Agents

Non-limiting examples of suitable pungent agents are selected from the group consisting of: capsicinoids (including capsaicin); vanillyl ethyl ether; vanillyl propyl ether; vanillyl butyl ether; vanillin propylene; glycol acetal; ethylvanillin propylene glycol acetal; capsaicin; gingerol; 4-(1-menthoxymethyl)-2-(3'-rnethoxy-4'-hydroxy-phenyl)-1, 3-dioxolane; pepper oil; pepper oleoresin; ginger oleoresin; nonylic acid vanillylamide; jamboo oleoresin; Zanthoxylum piperitum peel extract; sanshool; sanshoamide; black pepper extract; chavicine; piperine; spilanthol; and mixtures thereof. Other suitable pungent agents include polygodial, Tasmannia lanceolata extract, Capsicum extracts, or mixtures thereof. In one example, the pungent agent comprises a capsaicinoid, for example capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homodihydrocapsaicin, homocapsaicin, and/or nonivamide. In one example, the pungent agent comprises capsaicin.

Commercially available suitable pungent agents include OPTAHEAT (Symise Flavors), HOTACT (Lipo Chemicals), and HEATENOL (Sensient Flavors).

The fibrous element and/or fibrous structure and/or product comprising same may comprise a sufficient amount of the pungent agent to deliver a pungent taste and/or pungent smell, for example a controlled level of pungency to a user (enough to deter ingestion but not so much as to make a human and/or animal physically ill or to accidentally transfer significant amounts to a user's hands. In one example, the fibrous element and/or fibrous structure and/or product comprising the same may comprise greater than 0.0001% and/or greater than 0.001% and/or greater than 0.01% and/or greater than 0.1% and/or less than 20% and/or less than 15% and/or less than 10% and/or less than 5% and/or less than 2% and/or less than 1% and/or less than 0.5% and/or from about 0.0001% to about 10%, or from about 0.001% to about 2%, or from about 0.01% to about 1%, or from about 0.1% to about 0.5%, by weight of the pungent agent.

The pungent agent or parts thereof associated with a fibrous element and/or fibrous structure and/or product comprising the same may be present on a surface of the fibrous element and/or fibrous structure and/or product comprising the same. The pungent agent may migrate from within a fibrous element and/or fibrous structure and/or product comprising the same to an exterior surface thereof such that a human or animal experiences a pungent taste and/or pungent smell from the fibrous element and/or fibrous structure and/or product upon near contact or

actual contact with their mouth. In addition to and/or alternatively, the pungent agent may be applied to a surface of the fibrous element and/or fibrous structure and/or product comprising the same after the fibrous element and/or fibrous structure and/or product have been formed, such as in the way of a coating composition comprising the pungent agent, for example by spraying and/or printing and/or atomizing and/or dusting and/or powdering and/or coating and/or painting and/or otherwise depositing the pungent agent and/or composition comprising the pungent agent directly onto a surface of the fibrous element and/or fibrous structure and/or product. In one example, the pungent agent is present on the surface of the fibrous element and/or fibrous structure and/or product comprising the same at a level of at least 10ppb and/or at least 50ppb and/or from about 10 ppb to about 10,000ppm and/or from about 50ppb to about 5,000ppm and/or from about 50ppb to about 1,000ppm and/or from about 100ppb to about 500ppm and/or from about 10ppm to about 250ppm as determined after storage of the fibrous element and/or fibrous structure and/or product for one month 25°C and 60% relative humidity.

When the pungent agent and/or composition comprising the pungent agent is sprayed and/or printed and/or atomized and/or dusted and/or powdered and/or coated and/or painted and/or otherwise deposited onto a surface of the fibrous element and/or fibrous structure and/or product, the pungent agent and/or composition comprising the pungent agent may be non-aqueous, meaning that it comprises less than 20% and/or less than 15% and/or less than 10% and/or less than 5% and/or less than 3% and/or less than 1% and/or about 0% and/or 0% by weight water. The composition comprising the pungent agent may comprise 100% and/or 80% and/or 60% and/or 40% and/or 35% and/or 30% and/or greater than 0% to about 100% and/or from about 0.001% to about 80% and/or from about 0.001% to about 60% and/or from about 0.001% to about 40% and/or from about 0.1% to about 35% and/or from about 5% to about 30% by weight of the pungent agent.

The pungency of a pungent agent may be determined according to the well-known Scoville Scale and may be reported in Scoville heat units (SHU). The pungent agent may be selected from pungent agents having a pungency level of at least about 1,000,000 SHU and/or at least about 5,000,000 SHU and/or at least about 10,000,000 SHU and/or at least about 15,000,000 SHU. For comparison, the pungency level of capsaicin is about 16,000,000 SHU. Pungency may also be measured by high performance liquid chromatography and determined in American Spice Trade Association (ASTA) pungency units. A measurement of one part capsaicin per million corresponds to about 15 Scoville units and ASTA pungency units can be multiplied by 15 and reported as Scoville units.

Because it is desirable that the pungent agent be detectable in order to be an effective deterrent agent, it is generally desirable that the pungency not be masked by other agents, such as cooling agents like menthol and the like. In one example, the fibrous element and/or fibrous structure and/or product comprising the same are free of, for example less than 5% and/or less than 3% and/or less than 1% and/or less than 0.1% and/or less than 0.01% and/or less than 0.001% and/or about 0% and/or 0% by weight, cooling agents, for example menthol and/or eucalyptus.

For similar reasons, it is generally desirable that the pungent agent is readily available to a user of the fibrous element and/or fibrous structure and/or product comprising the same.

c. Emetic Agents

There are two main types of emetic agents: 1) those that work directly on the gastrointestinal tract of humans and animals, and 2) those that work indirectly by stimulating the areas of the brain that control vomiting. Non-limiting examples of suitable emetic agents that work directly on the gastrointestinal tracts are selected from the group consisting of: ipecac (ipecac syrup and/or ipecac powder) obtained from *Cephaelis ipecacuanha*, lobelia obtained from *Lobelia inflata*, mustard seed obtained from *Brassica juncea*, vomitoxin obtained from *Fusarium graminearum*, copper sulfate, and mixtures thereof. An example of an emetic that works indirectly by stimulating the areas of the brain that control vomiting is apomorphine (apomorphine hydrochloride).

Non-limiting Example of Method for Making Fibrous Elements

The fibrous elements, for example filaments, of the present invention comprising one or more deterrent agents present within the fibrous elements and/or on the fibrous elements may be made as shown in Figs. 3 and 4. As shown in Figs. 3 and 4, a method 20 for making a fibrous element 10, for example filament, according to the present invention comprises the steps of:

a. providing a fibrous element-forming composition 22, such as from a tank 24, comprising one or more fibrous element-forming materials and one or more deterrent agents, and optionally, one or more active agents and/or one or more polar solvents (such as water); and

b. spinning the fibrous element-forming composition 22, such as via a spinning die 26, into one or more fibrous elements 10, such as filaments, comprising the one or more fibrous element-forming materials and optionally, the one or more active agents and the one or more deterrent agents. In one example, one or more deterrent agents may be applied to a surface of the

one or more fibrous elements and/or to a fibrous structure comprising the fibrous elements. In another example, the fibrous element may be void or substantially void of deterrent agents, in which case, one or more deterrent agents would need to be applied to a surface of the fibrous element during and/or after spinning of the fibrous element.

The fibrous element-forming composition may be transported via suitable piping 28, with or without a pump 30, between the tank 24 and the spinning die 26. In one example, a pressurized tank 24, suitable for batch operation is filled with a suitable fibrous element-forming composition 22 for spinning. A pump 30, such as a Zenith®, type PEP II, having a capacity of 5.0 cubic centimeters per revolution (cc/rev), manufactured by Colfax Corporation, Zenith Pumps Division, of Monroe, N.C., USA may be used to facilitate transport of the fibrous element-forming composition 22 to a spinning die 26. The flow of the fibrous element-forming composition 22 from the pressurized tank 24 to the spinning die 26 may be controlled by adjusting the number of revolutions per minute (rpm) of the pump 30. Pipes 28 are used to connect the pressurized tank 24, the pump 30, and the spinning die 26 in order to transport (as represented by the arrows) the fibrous element-forming composition 22 from the tank 24 to the pump 30 and into the die 26.

The total level of the one or more fibrous element-forming materials present in the fibrous element 10, when active agents are present therein, may be less than 80% and/or less than 70% and/or less than 65% and/or 50% or less by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis and the total level of the one or more active agents, when present in the fibrous element may be greater than 20% and/or greater than 35% and/or 50% or greater 65% or greater and/or 80% or greater by weight on a dry fibrous element basis and/or dry soluble fibrous structure basis.

As shown in Figs. 3 and 4, the spinning die 26 may comprise a plurality of fibrous element-forming holes 32 that include a melt capillary 34 encircled by a concentric attenuation fluid hole 36 through which a fluid, such as air, passes to facilitate attenuation of the fibrous element-forming composition 22 into a fibrous element 10 as it exits the fibrous element-forming hole 32.

In one example, the spinning die 26 shown in Fig. 4 has two or more rows of circular extrusion nozzles (fibrous element-forming holes 32) spaced from one another at a pitch P of about 1.524 millimeters (about 0.060 inches). The nozzles have individual inner diameters of about 0.305 millimeters (about 0.012 inches) and individual outside diameters of about 0.813 millimeters (about 0.032 inches). Each individual nozzle comprises a melt capillary 34 encircled

by an annular and divergently flared orifice (concentric attenuation fluid hole 36) to supply attenuation air to each individual melt capillary 34. The fibrous element-forming composition 22 extruded through the nozzles is surrounded and attenuated by generally cylindrical, humidified air streams supplied through the orifices to produce fibrous elements 10.

Attenuation air can be provided by heating compressed air from a source by an electrical-resistance heater, for example, a heater manufactured by Chromalox, Division of Emerson Electric, of Pittsburgh, Pa., USA. An appropriate quantity of steam was added to saturate or nearly saturate the heated air at the conditions in the electrically heated, thermostatically controlled delivery pipe. Condensate was removed in an electrically heated, thermostatically controlled, separator.

The embryonic fibrous elements are dried by a drying air stream having a temperature from about 149°C (about 300°F) to about 315°C (about 600°F) by an electrical resistance heater (not shown) supplied through drying nozzles and discharged at an angle of about 90° relative to the general orientation of the embryonic fibrous elements being spun. The dried fibrous elements may be collected on a collection device, such as a belt or fabric, in one example a belt or fabric capable of imparting a pattern, for example a non-random repeating pattern to a soluble fibrous structure formed as a result of collecting the fibrous elements on the belt or fabric. The addition of a vacuum source directly under the formation zone may be used to aid collection of the fibrous elements on the collection device. The spinning and collection of the fibrous elements produce a soluble fibrous structure comprising inter-entangled fibrous elements, for example filaments.

In one example, during the spinning step, any volatile solvent, such as water, present in the fibrous element-forming composition 22 is removed, such as by drying, as the fibrous element 10 is formed. In one example, greater than 30% and/or greater than 40% and/or greater than 50% of the weight of the fibrous element-forming composition's volatile solvent, such as water, is removed during the spinning step, such as by drying the fibrous element 10 being produced.

The fibrous element-forming composition may comprise any suitable total level of fibrous element-forming materials and any suitable level of active agents so long as the fibrous element produced from the fibrous element-forming composition comprises a total level of fibrous element-forming materials in the fibrous element of from about 5% to 50% or less by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis and a total level of active agents in the fibrous element of from 50% to about 95%

by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis.

In one example, the fibrous element-forming composition may comprise any suitable total level of fibrous element-forming materials and any suitable level of active agents so long as the fibrous element produced from the fibrous element-forming composition comprises a total level of fibrous element-forming materials in the fibrous element and/or particle of from about 5% to 50% or less by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis and a total level of active agents in the fibrous element and/or particle of from 50% to about 95% by weight on a dry fibrous element basis and/or dry particle basis and/or dry soluble fibrous structure basis, wherein the weight ratio of fibrous element-forming material to total level of active agents is 1 or less.

In one example, the fibrous element-forming composition comprises from about 1% and/or from about 5% and/or from about 10% to about 50% and/or to about 40% and/or to about 30% and/or to about 20% by weight of the fibrous element-forming composition of fibrous element-forming materials; from about 1% and/or from about 5% and/or from about 10% to about 50% and/or to about 40% and/or to about 30% and/or to about 20% by weight of the fibrous element-forming composition of active agents; and from about 20% and/or from about 25% and/or from about 30% and/or from about 40% and/or to about 80% and/or to about 70% and/or to about 60% and/or to about 50% by weight of the fibrous element-forming composition of a volatile solvent, such as water. The fibrous element-forming composition may comprise minor amounts of other active agents, such as less than 10% and/or less than 5% and/or less than 3% and/or less than 1% by weight of the fibrous element-forming composition of plasticizers, pH adjusting agents, and other active agents.

The fibrous element-forming composition is spun into one or more fibrous elements and/or particles by any suitable spinning process, such as meltblowing, spunbonding, electro-spinning, and/or rotary spinning. In one example, the fibrous element-forming composition is spun into a plurality of fibrous elements and/or particles by meltblowing. For example, the fibrous element-forming composition may be pumped from a tank to a meltblown spinnerette. Upon exiting one or more of the fibrous element-forming holes in the spinnerette, the fibrous element-forming composition is attenuated with air to create one or more fibrous elements and/or particles. The fibrous elements and/or particles may then be dried to remove any remaining solvent used for spinning, such as the water.

The fibrous elements and/or particles of the present invention may be collected on a belt (not shown), such as a patterned belt, for example in an inter-entangled manner such that a soluble fibrous structure comprising the fibrous elements and/or particles is formed.

Methods of Use

In one example, the soluble fibrous structures comprising one or more fabric care active agents according the present invention may be utilized in a method for treating a fabric article. The method of treating a fabric article may comprise one or more steps selected from the group consisting of: (a) pre-treating the fabric article before washing the fabric article; (b) contacting the fabric article with a wash liquor formed by contacting the soluble fibrous structure with water; (c) contacting the fabric article with the soluble fibrous structure in a dryer; (d) drying the fabric article in the presence of the soluble fibrous structure in a dryer; and (e) combinations thereof.

In some embodiments, the method may further comprise the step of pre-moistening the soluble fibrous structure prior to contacting it to the fabric article to be pre-treated. For example, the soluble fibrous structure can be pre-moistened with water and then adhered to a portion of the fabric comprising a stain that is to be pre-treated. Alternatively, the fabric may be moistened and the fibrous structure placed on or adhered thereto. In some embodiments, the method may further comprise the step of selecting of only a portion of the soluble fibrous structure for use in treating a fabric article. For example, if only one fabric care article is to be treated, a portion of the soluble fibrous structure may be cut and/or torn away and either placed on or adhered to the fabric or placed into water to form a relatively small amount of wash liquor which is then used to pre-treat the fabric. In this way, the user may customize the fabric treatment method according to the task at hand. In some embodiments, at least a portion of a soluble fibrous structure may be applied to the fabric to be treated using a device. Exemplary devices include, but are not limited to, brushes and sponges. Any one or more of the aforementioned steps may be repeated to achieve the desired fabric treatment benefit.

In another example, the soluble fibrous structures comprising one or more hair care active agents according the present invention may be utilized in a method for treating hair. The method of treating hair may comprise one or more steps selected from the group consisting of: (a) pre-treating the hair before washing the hair; (b) contacting the hair with a wash liquor formed by contacting the soluble fibrous structure with water; (c) post-treating the hair after washing the

hair; (d) contacting the hair with a conditioning fluid formed by contacting the soluble fibrous structure with water; and (e) combinations thereof.

Non-limiting Examples

Example 1 – A fibrous element, for example a filament, comprising a deterrent agent is made as follows. A fibrous element-forming composition is prepared by adding with stirring at 100-150 rpm into an appropriately sized and cleaned vessel 54% by weight distilled water. Low hydrolysis vinyl acetate-vinyl alcohol copolymer resin powders: 10% by weight of low hydrolysis vinyl acetate-vinyl alcohol copolymer resin powder (fibrous element-forming material) (Poval® PVA 505 commercially available from Kuraray Co. Ltd. of Houston, TX) and 5% by weight of low hydrolysis vinyl acetate-vinyl alcohol copolymer resin powder (fibrous element-forming material) (Poval® PVA 420H commercially available from Kuraray Co. Ltd. of Houston, TX) are weighed into a suitable container and slowly added to the water in small increments using a spatula while continuing to stir while avoiding the formation of visible lumps. The mixing speed is adjusted to minimize foam formation. Then the mixture is slowly heated to 75°C for 2 hours after which 20% by weight of a linear alkylbenzene sulfonate surfactant (active agent – anionic surfactant) and 10% by weight of an alkyl ethoxy sulfate surfactant (active agent – anionic surfactant) are added and 1% by weight of a deterrent agent described herein is then added to the mixture. The mixture is then heated to 75°C while continuing to stir for 45 minutes and then allowed to cool to 23°C to form a premix. This premix is then ready for spinning into fibrous elements as described herein. In one example, a plurality of the spun fibrous elements may be inter-entangled and collected on a collection device to form a fibrous structure comprising the fibrous elements.

Example 2 - A fibrous element, for example a filament, comprising a deterrent agent is made as follows. A fibrous element-forming composition is prepared by adding with stirring at 100-150 rpm into an appropriately sized and cleaned vessel 54% by weight distilled water. 14% by weight of carboxymethylcellulose (fibrous element-forming material) and 1% by weight of an extensional aid (polyacrylamide) are weighed into a suitable container and slowly added to the water in small increments using a spatula while continuing to stir while avoiding the formation of visible lumps. The mixing speed is adjusted to minimize foam formation. Then the mixture is slowly heated to 75°C for 2 hours after which 20% by weight of a linear alkylbenzene sulfonate surfactant (active agent – anionic surfactant) and 10% by weight of an alkyl ethoxy sulfate

surfactant (active agent – anionic surfactant) are added and 1% by weight of a deterrent agent described herein is then added to the mixture. The mixture is then heated to 75°C while continuing to stir for 45 minutes and then allowed to cool to 23°C to form a premix. This premix is then ready for spinning into fibrous elements as described herein. In one example, a plurality of the spun fibrous elements may be inter-entangled and collected on a collection device to form a fibrous structure comprising the fibrous elements.

Example 3 – A fibrous element, for example a filament, comprising a deterrent agent is made as follows. A fibrous element-forming composition is prepared by adding with stirring at 100-150 rpm into an appropriately sized and cleaned vessel 54% by weight distilled water. Low hydrolysis vinyl acetate-vinyl alcohol copolymer resin powders: 11% by weight of low hydrolysis vinyl acetate-vinyl alcohol copolymer resin powder (fibrous element-forming material) (Poval® PVA 505 commercially available from Kuraray Co. Ltd. of Houston, TX) and 5% by weight of low hydrolysis vinyl acetate-vinyl alcohol copolymer resin powder (fibrous element-forming material) (Poval® PVA 420H commercially available from Kuraray Co. Ltd. of Houston, TX) are weighed into a suitable container and slowly added to the water in small increments using a spatula while continuing to stir while avoiding the formation of visible lumps. The mixing speed is adjusted to minimize foam formation. Then the mixture is slowly heated to 75°C for 2 hours after which 20% by weight of a linear alkylbenzene sulfonate surfactant (active agent – anionic surfactant) and 10% by weight of an alkyl ethoxy sulfate surfactant (active agent – anionic surfactant) are added to the mixture. The mixture is then heated to 75°C while continuing to stir for 45 minutes and then allowed to cool to 23°C to form a premix. This premix is then ready for spinning into fibrous elements as described herein. The fibrous element is then contacted with denatonium benzoate (deterrent agent), for example as a solution and/or powder, to coat the fibrous element. In one example, a plurality of the spun fibrous elements (coated and/or not coated with a deterrent agent) may be inter-entangled and collected on a collection device to form a fibrous structure comprising the fibrous elements and then at least one surface of the fibrous structure may be contacted with denatonium benzoate (deterrent agent), for example as a solution and/or powder, to coat the surface of the fibrous structure.

Example 4 - A fibrous element, for example a filament, comprising a deterrent agent is made as follows. A fibrous element-forming composition is prepared by adding with stirring at 100-150 rpm into an appropriately sized and cleaned vessel 54% by weight distilled water. 15%

by weight of carboxymethylcellulose (fibrous element-forming material) and 1% by weight of an extensional aid (polyacrylamide) are weighed into a suitable container and slowly added to the water in small increments using a spatula while continuing to stir while avoiding the formation of visible lumps. The mixing speed is adjusted to minimize foam formation. Then the mixture is slowly heated to 75°C for 2 hours after which 20% by weight of a linear alkylbenzene sulfonate surfactant (active agent – anionic surfactant) and 10% by weight of an alkyl ethoxy sulfate surfactant (active agent – anionic surfactant) are added to the mixture. The mixture is then heated to 75°C while continuing to stir for 45 minutes and then allowed to cool to 23°C to form a premix. This premix is then ready for spinning into fibrous elements as described herein. The fibrous element is then contacted with denatonium benzoate (deterrent agent), for example in a solution, to coat the fibrous element. In one example, a plurality of the spun fibrous elements (coated and/or not coated with a deterrent agent) may be inter-entangled and collected on a collection device to form a fibrous structure comprising the fibrous elements.

The fibrous element is then contacted with denatonium benzoate (deterrent agent), for example as a solution and/or powder, to coat the fibrous element.

In one example, a plurality of the spun fibrous elements may be inter-entangled and collected on a collection device to form a fibrous structure comprising the fibrous elements and then at least one surface of the fibrous structure may be contacted with denatonium benzoate (deterrent agent), for example as a solution and/or powder, to coat the surface of the fibrous structure.

Test Methods

Unless otherwise indicated, all tests described herein including those described under the Definitions section and the following test methods are conducted on samples that have been conditioned in a conditioned room at a temperature of 23°C ± 1°C and a relative humidity of 50% ± 2% for 2 hours prior to the test unless otherwise indicated. Samples conditioned as described herein are considered dry samples (such as "dry fibrous elements") for purposes of this invention. Further, all tests are conducted in such conditioned room.

Water Content Test Method

The water (moisture) content present in a filament and/or fiber and/or soluble fibrous structure is measured using the following Water Content Test Method.

A filament and/or soluble fibrous structure or portion thereof ("sample") is placed in a conditioned room at a temperature of 23°C ± 1°C and a relative humidity of 50% ± 2% for at least 24 hours prior to testing. The weight of the sample is recorded when no further weight change is detected for at least a 5 minute period. Record this weight as the "equilibrium weight" of the sample. Next, place the sample in a drying oven for 24 hours at 70°C with a relative humidity of about 4% to dry the sample. After the 24 hours of drying, immediately weigh the sample. Record this weight as the "dry weight" of the sample. The water (moisture) content of the sample is calculated as follows:

$$\%\ \text{Water (moisture) in sample} = 100\% \times \frac{\text{(Equilibrium weight of sample – Dry weight of sample)}}{\text{Dry weight of sample}}$$

The % Water (moisture) in sample for 3 replicates is averaged to give the reported % Water (moisture) in sample.

Dissolution Test Method

Apparatus and Materials (Figs. 5 through 7):

600 mL Beaker 38

Magnetic Stirrer 40 (Labline Model No. 1250 or equivalent)

Magnetic Stirring Rod 42 (5 cm)

Thermometer (1 to 100°C +/- 1 °C)

Cutting Die -- Stainless Steel cutting die with dimensions 3.8 cm x 3.2 cm

Timer (0-3,600 seconds or 1 hour), accurate to the nearest second. Timer used should have sufficient total time measurement range if sample exhibits dissolution time greater than 3,600 seconds. However, timer needs to be accurate to the nearest second.

Polaroid 35 mm Slide Mount 44 (commercially available from Polaroid Corporation or equivalent)

35 mm Slide Mount Holder 46 (or equivalent)

City of Cincinnati Water or equivalent having the following properties: Total Hardness = 155 mg/L as $CaCO_3$; Calcium content = 33.2 mg/L; Magnesium content = 17.5 mg/L; Phosphate content = 0.0462.

Test Protocol

Equilibrate samples in constant temperature and humidity environment of 23°C ± 1 °C and 50%RH ± 2% for at least 2 hours.

Measure the basis weight of the sample materials using Basis Weight Method defined herein.

Cut three dissolution test specimens from soluble fibrous structure sample using cutting die (3.8 cm x 3.2 cm), so it fits within the 35 mm slide mount 44 which has an open area dimensions 24 x 36 mm.

Lock each specimen in a separate 35 mm slide mount 44.

Place magnetic stirring rod 42 into the 600 mL beaker 38.

Turn on the city water tap flow (or equivalent) and measure water temperature with thermometer and, if necessary, adjust the hot or cold water to maintain it at the testing temperature. Testing temperature is 15°C ± 1°C water. Once at testing temperature, fill beaker 240 with 500 mL ± 5 mL of the 15°C ± 1°C city water.

Place full beaker 38 on magnetic stirrer 40, turn on stirrer 40, and adjust stir speed until a vortex develops and the bottom of the vortex is at the 400 mL mark on the beaker 38.

Secure the 35 mm slide mount 44 in the alligator clamp 48 of the 35 mm slide mount holder 46 such that the long end 50 of the slide mount 44 is parallel to the water surface. The alligator clamp 48 should be positioned in the middle of the long end 50 of the slide mount 44. The depth adjuster 52 of the holder 46 should be set so that the distance between the bottom of the depth adjuster 52 and the bottom of the alligator clamp 48 is 11 ± 0.125 inches. This set up will position the sample surface perpendicular to the flow of the water. A slightly modified example of an arrangement of a 35 mm slide mount and slide mount holder are shown in Figs. 1-3 of U.S. Patent No. 6,787,512.

In one motion, drop the secured slide and clamp into the water and start the timer. The sample is dropped so that the sample is centered in the beaker. Disintegration occurs when the soluble fibrous structure breaks apart. Record this as the disintegration time. When all of the visible soluble fibrous structure is released from the slide mount, raise the slide out of the water while continuing the monitor the solution for undissolved soluble fibrous structure fragments. Dissolution occurs when all soluble fibrous structure fragments are no longer visible. Record this as the dissolution time.

Three replicates of each sample are run and the average disintegration and dissolution times are recorded. Average disintegration and dissolution times are in units of seconds.

The average disintegration and dissolution times are normalized for basis weight by dividing each by the sample basis weight as determined by the Basis Weight Method defined

herein. Basis weight normalized disintegration and dissolution times are in units of seconds/gsm of sample (s/(g/m^2)).

Diameter Test Method

The diameter of a discrete fibrous element or a fibrous element within a soluble fibrous structure or film is determined by using a Scanning Electron Microscope (SEM) or an Optical Microscope and an image analysis software. A magnification of 200 to 10,000 times is chosen such that the fibrous elements are suitably enlarged for measurement. When using the SEM, the samples are sputtered with gold or a palladium compound to avoid electric charging and vibrations of the fibrous element in the electron beam. A manual procedure for determining the fibrous element diameters is used from the image (on monitor screen) taken with the SEM or the optical microscope. Using a mouse and a cursor tool, the edge of a randomly selected fibrous element is sought and then measured across its width (i.e., perpendicular to fibrous element direction at that point) to the other edge of the fibrous element. A scaled and calibrated image analysis tool provides the scaling to get actual reading in μm. For fibrous elements within a soluble fibrous structure or film, several fibrous element are randomly selected across the sample of the soluble fibrous structure or film using the SEM or the optical microscope. At least two portions the soluble fibrous structure or film (or fibrous structure inside a product) are cut and tested in this manner. Altogether at least 100 such measurements are made and then all data are recorded for statistical analysis. The recorded data are used to calculate average (mean) of the fibrous element diameters, standard deviation of the fibrous element diameters, and median of the fibrous element diameters.

Another useful statistic is the calculation of the amount of the population of fibrous elements that is below a certain upper limit. To determine this statistic, the software is programmed to count how many results of the fibrous element diameters are below an upper limit and that count (divided by total number of data and multiplied by 100%) is reported in percent as percent below the upper limit, such as percent below 1 micrometer diameter or %-submicron, for example. We denote the measured diameter (in μm) of an individual circular fibrous element as di.

In case the fibrous elements have non-circular cross-sections, the measurement of the fibrous element diameter is determined as and set equal to the hydraulic diameter which is four times the cross-sectional area of the fibrous element divided by the perimeter of the cross-section

of the fibrous element (outer perimeter in case of hollow fibrous elements). The number-average diameter, alternatively average diameter is calculated as:

$$d_{num} = \frac{\sum_{i=1}^{n} d_i}{n}$$

Thickness Method

Thickness of a soluble fibrous structure or film is measured by cutting 5 samples of a soluble fibrous structure or film sample such that each cut sample is larger in size than a load foot loading surface of a VIR Electronic Thickness Tester Model II available from Thwing-Albert Instrument Company, Philadelphia, PA. Typically, the load foot loading surface has a circular surface area of about 3.14 in^2. The sample is confined between a horizontal flat surface and the load foot loading surface. The load foot loading surface applies a confining pressure to the sample of 15.5 g/cm^2. The caliper of each sample is the resulting gap between the flat surface and the load foot loading surface. The caliper is calculated as the average caliper of the five samples. The result is reported in millimeters (mm).

Basis Weight Test Method

Basis weight of a fibrous structure sample is measured by selecting twelve (12) individual fibrous structure samples and making two stacks of six individual samples each. If the individual samples are connected to one another vie perforation lines, the perforation lines must be aligned on the same side when stacking the individual samples. A precision cutter is used to cut each stack into exactly 3.5 in. x 3.5 in. squares. The two stacks of cut squares are combined to make a basis weight pad of twelve squares thick. The basis weight pad is then weighed on a top loading balance with a minimum resolution of 0.01 g. The top loading balance must be protected from air drafts and other disturbances using a draft shield. Weights are recorded when the readings on the top loading balance become constant. The Basis Weight is calculated as follows:

$$\text{Basis Weight (lbs/3000 ft}^2\text{)} = \frac{\text{Weight of basis weight pad (g) x 3000 ft}^2}{453.6\ \text{g/lbs x 12 samples x [12.25 in}^2\text{ (Area of basis weight pad)/144 in}^2\text{]}}$$

$$\text{Basis Weight (g/m}^2\text{)} = \frac{\text{Weight of basis weight pad (g) x 10,000 cm}^2\text{/m}^2}{79.0321\ \text{cm}^2\text{ (Area of basis weight pad) x 12 samples}}$$

If fibrous structure sample is smaller than 3.5 in. x 3.5 in., then smaller sampling areas can be used for basis weight determination with associated changes to the calculations.

Weight Average Molecular Weight Test Method

The weight average molecular weight (Mw) of a material, such as a polymer, is determined by Gel Permeation Chromatography (GPC) using a mixed bed column. A high performance liquid chromatograph (HPLC) having the following components: Millenium®, Model 600E pump, system controller and controller software Version 3.2, Model 717 Plus autosampler and CHM-009246 column heater, all manufactured by Waters Corporation of Milford, MA, USA, is utilized. The column is a PL gel 20 µm Mixed A column (gel molecular weight ranges from 1,000 g/mol to 40,000,000 g/mol) having a length of 600 mm and an internal diameter of 7.5 mm and the guard column is a PL gel 20 µm, 50 mm length, 7.5 mm ID. The column temperature is 55°C and the injection volume is 200 µL. The detector is a DAWN® Enhanced Optical System (EOS) including Astra® software, Version 4.73.04 detector software, manufactured by Wyatt Technology of Santa Barbara, CA, USA, laser-light scattering detector with K5 cell and 690 nm laser. Gain on odd numbered detectors set at 101. Gain on even numbered detectors set to 20.9. Wyatt Technology's Optilab® differential refractometer set at 50°C. Gain set at 10. The mobile phase is HPLC grade dimethylsulfoxide with 0.1% w/v LiBr and the mobile phase flow rate is 1 mL/min, isocratic. The run time is 30 minutes.

A sample is prepared by dissolving the material in the mobile phase at nominally 3 mg of material /1 mL of mobile phase. The sample is capped and then stirred for about 5 minutes using a magnetic stirrer. The sample is then placed in an 85°C convection oven for 60 minutes. The sample is then allowed to cool undisturbed to room temperature. The sample is then filtered through a 5µm Nylon membrane, type Spartan-25, manufactured by Schleicher & Schuell, of Keene, NH, USA, into a 5 milliliter (mL) autosampler vial using a 5 mL syringe.

For each series of samples measured (3 or more samples of a material), a blank sample of solvent is injected onto the column. Then a check sample is prepared in a manner similar to that related to the samples described above. The check sample comprises 2 mg/mL of pullulan (Polymer Laboratories) having a weight average molecular weight of 47,300 g/mol. The check sample is analyzed prior to analyzing each set of samples. Tests on the blank sample, check sample, and material test samples are run in duplicate. The final run is a run of the blank sample. The light scattering detector and differential refractometer is run in accordance with the "Dawn EOS Light Scattering Instrument Hardware Manual" and "Optilab® DSP Interferometric

Refractometer Hardware Manual," both manufactured by Wyatt Technology Corp., of Santa Barbara, CA, USA .

The weight average molecular weight of the sample is calculated using the detector software. A dn/dc (differential change of refractive index with concentration) value of 0.066 is used. The baselines for laser light detectors and the refractive index detector are corrected to remove the contributions from the detector dark current and solvent scattering. If a laser light detector signal is saturated or shows excessive noise, it is not used in the calculation of the molecular mass. The regions for the molecular weight characterization are selected such that both the signals for the 90° detector for the laser-light scattering and refractive index are greater than 3 times their respective baseline noise levels. Typically the high molecular weight side of the chromatogram is limited by the refractive index signal and the low molecular weight side is limited by the laser light signal.

The weight average molecular weight can be calculated using a "first order Zimm plot" as defined in the detector software. If the weight average molecular weight of the sample is greater than 1,000,000 g/mol, both the first and second order Zimm plots are calculated, and the result with the least error from a regression fit is used to calculate the molecular mass. The reported weight average molecular weight is the average of the two runs of the material test sample.

Tensile Test Method: Elongation, Tensile Strength, TEA and Modulus

Elongation, Tensile Strength, TEA, Secant Modulus and Tangent Modulus are measured on a constant rate of extension tensile tester with computer interface (a suitable instrument is the MTS Insight using Testworks 4.0 Software, as available from MTS Systems Corp., Eden Prairie, MN) using a load cell for which the forces measured are within 10% to 90% of the limit of the cell. Both the movable (upper) and stationary (lower) pneumatic jaws are fitted with rubber faced grips, 25.4 mm in height and wider than the width of the test specimen. An air pressure of about 80 psi is supplied to the jaws. All testing is performed in a conditioned room maintained at about 23 °C ± 1 C° and about 50 % ± 2 % relative humidity. Samples are conditioned under the same conditions for 2 hours before testing.

Eight specimens of soluble fibrous structure and/or dissolving fibrous structure are divided into two stacks of four specimens each. The specimens in each stack are consistently oriented with respect to machine direction (MD) and cross direction (CD). One of the stacks is designated for testing in the MD and the other for CD. Using a one inch precision cutter

(Thwing Albert JDC-1-10, or similar) cut four MD strips from one stack, and four CD strips from the other, with dimensions of 2.54 cm ± 0.02 cm wide by at least 50 mm long.

Program the tensile tester to perform an extension test, collecting force and extension data at an acquisition rate of 100 Hz. Initially lower the crosshead 6 mm at a rate of 5.08 cm/min to introduce slack in the specimen, then raise the crosshead at a rate of 5.08 cm/min until the specimen breaks. The break sensitivity is set to 80%, i.e., the test is terminated when the measured force drops to 20% of the maximum peak force, after which the crosshead is returned to its original position.

Set the gage length to 2.54 cm. Zero the crosshead. Insert a specimen into the upper grip, aligning it vertically within the upper and lower jaws and close the upper grips. With the sample hanging from the top grips, zero the load cell. Insert the specimen into the lower grips and close. With the grips closed the specimen should be under enough tension to eliminate any slack but exhibits a force less than 3.0 g on the load cell. Start the tensile tester and data collection. Repeat testing in like fashion for all four CD and four MD specimens.

Program the software to calculate the following from the constructed force (g) verses extension (cm) curve:

Tensile Strength is the maximum peak force (g) divided by the specimen width (cm) and reported as g/cm to the nearest 1.0 g/cm.

Adjusted Gage Length is calculated as the extension measured at 3.0 g of force (cm) added to the original gage length (cm).

Elongation is calculated as the extension at maximum peak force (cm) divided by the Adjusted Gage Length (cm) multiplied by 100 and reported as % to the nearest 0.1%

Total Energy (TEA) is calculated as the area under the force curve integrated from zero extension to the extension at the maximum peak force (g*cm), divided by the product of the adjusted Gage Length (cm) and specimen width (cm) and is reported out to the nearest 1 $g*cm/cm^2$.

Replot the force (g) verses extension (cm) curve as a force (g) verses strain (%) curve. Strain is herein defined as the extension (cm) divided by the Adjusted Gage Length (cm) x 100.

Program the software to calculate the following from the constructed force (g) verses strain (%) curve:

The Secant Modulus is calculated from a least squares linear fit of the steepest slope of the force vs strain curve using a cord that has a rise of at least 20% of the peak force. This slope is then divided by the specimen width (2.54 cm) and reported to the nearest 1.0 g/cm.

Tangent Modulus is calculated as the slope the line drawn between the two data points on the force (g) versus strain (%) curve. The first data point used is the point recorded at 28 g force, and the second data point used is the point recorded at 48 g force. This slope is then divided by the specimen width (2.54 cm) and reported to the nearest 1.0 g/cm.

The Tensile Strength (g/cm), Elongation (%), Total Energy (g*cm/cm^2), Secant Modulus (g/cm) and Tangent Modulus (g/cm) are calculated for the four CD specimens and the four MD specimens. Calculate an average for each parameter separately for the CD and MD specimens.

Calculations:

Total Dry Tensile Strength (TDT) = MD Tensile Strength (g/cm) + CD Tensile Strength (g/cm)

Geometric Mean Tensile = Square Root of [MD Tensile Strength (g/cm) x CD Tensile Strength (g/cm)]

Tensile Ratio = MD Tensile Strength (g/cm) / CD Tensile Strength (g/cm)

Geometric Mean Peak Elongation = Square Root of [MD Elongation (%) x CD Elongation (%)]

Total TEA = MD TEA (g*cm/cm^2) + CD TEA (g*cm/cm^2)

Geometric Mean TEA = Square Root of [MD TEA (g*cm/cm^2) x CD TEA (g*cm/cm^2)]

Geometric Mean Tangent Modulus = Square Root of [MD Tangent Modulus (g/cm) x CD Tangent Modulus (g/cm)]

Total Tangent Modulus = MD Tangent Modulus (g/cm) + CD Tangent Modulus (g/cm)

Geometric Mean Secant Modulus = Square Root of [MD Secant Modulus (g/cm) x CD Secant Modulus (g/cm)]

Total Secant Modulus = MD Secant Modulus (g/cm) + CD Secant Modulus (g/cm)

Plate Stiffness Test Method

As used herein, the "Plate Stiffness" test is a measure of stiffness of a flat sample as it is deformed downward into a hole beneath the sample. For the test, the sample is modeled as an infinite plate with thickness "t" that resides on a flat surface where it is centered over a hole with radius "R". A central force "F" applied to the tissue directly over the center of the hole deflects the tissue down into the hole by a distance "w". For a linear elastic material the deflection can be predicted by:

$$w = \frac{3F}{4\pi Et^3}(1-v)(3+v)R^2$$

where "E" is the effective linear elastic modulus, "v" is the Poisson's ratio, "R" is the radius of the hole, and "t" is the thickness of the tissue, taken as the caliper in millimeters measured on a stack of 5 tissues under a load of about 0.29 psi. Taking Poisson's ratio as 0.1 (the solution is not highly sensitive to this parameter, so the inaccuracy due to the assumed value is likely to be minor), the previous equation can be rewritten for "w" to estimate the effective modulus as a function of the flexibility test results:

$$E \approx \frac{3R^2}{4t^3} \frac{F}{w}$$

The test results are carried out using an MTS Alliance RT/1 testing machine (MTS Systems Corp., Eden Prairie, Minn.) with a 100N load cell. As a stack of five tissue sheets at least 2.5-inches square sits centered over a hole of radius 15.75 mm on a support plate, a blunt probe of 3.15 mm radius descends at a speed of 20 mm/min. When the probe tip descends to 1 mm below the plane of the support plate, the test is terminated. The maximum slope in grams of force/mm over any 0.5 mm span during the test is recorded (this maximum slope generally occurs at the end of the stroke). The load cell monitors the applied force and the position of the probe tip relative to the plane of the support plate is also monitored. The peak load is recorded, and "E" is estimated using the above equation.

The Plate Stiffness "S" per unit width can then be calculated as:

$$S = \frac{Et^3}{12}$$

and is expressed in units of Newtons-millimeters. The Testworks program uses the following formula to calculate stiffness:

$$S = (F/w)[(3+v)R^2/16\pi]$$

wherein "F/w" is max slope (force divided by deflection), "v" is Poisson's ratio taken as 0.1, and "R" is the ring radius.

Fibrous Element Composition Test Method

In order to prepare fibrous elements for fibrous element composition measurement, the fibrous elements must be conditioned by removing any coating compositions and/or materials present on the external surfaces of the fibrous elements that are removable. A chemical analysis of the conditioned fibrous elements is then completed to determine the compositional make-up of the fibrous elements with respect to the fibrous element-forming materials and the active agents and the level of the fibrous element-forming materials and active agents present in the fibrous elements.

The compositional make-up of the fibrous elements with respect to the fibrous element-forming material and the active agents can also be determined by completing a cross-section analysis using TOF-SIMs or SEM. Still another method for determining compositional make-up of the fibrous elements uses a fluorescent dye as a marker. In addition, as always, a manufacturer of fibrous elements should know the compositions of their fibrous elements.

Median Particle Size Test Method

This test method must be used to determine median particle size.

The median particle size test is conducted to determine the median particle size of the seed material using ASTM D 502 – 89, "Standard Test Method for Particle Size of Soaps and Other Detergents", approved May 26, 1989, with a further specification for sieve sizes used in the analysis. Following section 7, "Procedure using machine-sieving method," a nest of clean dry sieves containing U.S. Standard (ASTM E 11) sieves #8 (2360 um), #12 (1700 um), #16 (1180 um), #20 (850 um), #30 (600 um), #40 (425 um), #50 (300 um), #70 (212 um), #100 (150 um) is required. The prescribed Machine-Sieving Method is used with the above sieve nest. The seed material is used as the sample. A suitable sieve-shaking machine can be obtained from W.S. Tyler Company of Mentor, Ohio, U.S.A.

The data are plotted on a semi-log plot with the micron size opening of each sieve plotted against the logarithmic abscissa and the cumulative mass percent (Q_3) plotted against the linear ordinate. An example of the above data representation is given in ISO 9276-1:1998, "Representation of results of particle size analysis – Part 1: Graphical Representation", Figure A.4. The seed material median particle size (D_{50}), for the purpose of this invention, is defined as the abscissa value at the point where the cumulative mass percent is equal to 50 percent, and is calculated by a straight line interpolation between the data points directly above (a50) and below (b50) the 50% value using the following equation:

$$D_{50} = 10\text{^}[\text{Log}(D_{a50}) - (\text{Log}(D_{a50}) - \text{Log}(D_{b50}))*(Q_{a50} - 50\%)/(Q_{a50} - Q_{b50})]$$

where Q_{a50} and Q_{b50} are the cumulative mass percentile values of the data immediately above and below the 50^{th} percentile, respectively; and D_{a50} and D_{b50} are the micron sieve size values corresponding to these data.

In the event that the 50^{th} percentile value falls below the finest sieve size (150 um) or above the coarsest sieve size (2360 um), then additional sieves must be added to the nest following a geometric progression of not greater than 1.5, until the median falls between two measured sieve sizes.

The Distribution Span of the Seed Material is a measure of the breadth of the seed size distribution about the median. It is calculated according to the following:

$$\text{Span} = (D_{84}/D_{50} + D_{50}/D_{16}) / 2$$

Where D_{50} is the median particle size and D_{84} and D_{16} are the particle sizes at the sixteenth and eighty-fourth percentiles on the cumulative mass percent retained plot, respectively.

In the event that the D_{16} value falls below the finest sieve size (150 um), then the span is calculated according to the following:

$$\text{Span} = (D_{84}/D_{50}).$$

In the event that the D_{84} value falls above the coarsest sieve size (2360 um), then the span is calculated according to the following:

$$\text{Span} = (D_{50}/D_{16}).$$

In the event that the D_{16} value falls below the finest sieve size (150 um) and the D_{84} value falls above the coarsest sieve size (2360 um), then the distribution span is taken to be a maximum value of 5.7.

The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm."

The citation of any document is not an admission that it is prior art with respect to any invention disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or discloses any such invention. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the same term in a document referenced herein, the meaning or definition assigned to that term in this document shall govern.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is

therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

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What is claimed is:

1. A water-soluble fibrous structure comprising a plurality of water-soluble fibrous elements, wherein the water-soluble fibrous structure comprises an active agent and one or more deterrent agents selected from the group consisting of: bittering agents; pungent agents; emetic agents; and mixtures thereof, and wherein the plurality of water-soluble fibrous elements comprise a hydroxyl polymer selected from the group consisting of: polyvinyl alcohol; starch and derivatives thereof; and mixtures thereof.

2. The water-soluble fibrous structure according to Claim 1 wherein the deterrent agent comprises a particle present within an interstice of the water-soluble fibrous structure.

3. The water-soluble fibrous structure according to Claim 2 wherein the water-soluble fibrous structure is a coformed water-soluble fibrous structure.

4. The water-soluble fibrous structure according to Claim 1 wherein the deterrent agent is present on a surface of the water-soluble fibrous structure.

5. The water-soluble fibrous structure according to Claim 1 wherein the deterrent agent is present within at least one of the water-soluble fibrous elements.

6. The water-soluble fibrous structure according to Claim 1 wherein the active agent is released from the water-soluble fibrous structure when the water-soluble fibrous structure is exposed to conditions of intended use.

7. The water-soluble fibrous structure according to Claim 6 wherein the active agent comprises a particle present within the water-soluble fibrous structure.

8. The water-soluble fibrous structure according to Claim 7 wherein the water-soluble fibrous structure is a coformed water-soluble fibrous structure.

9. The water-soluble fibrous structure according to Claim 6 wherein the active agent is present on a surface of the water-soluble fibrous structure.

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10. The water-soluble fibrous structure according to Claim 6 wherein the active agent comprises a surfactant.

11. The water-soluble fibrous structure according to Claim 10 wherein the surfactant is selected from the group consisting of: anionic surfactants, cationic surfactants, nonionic surfactants, zwitterionic surfactants, and mixtures thereof.

12. The water-soluble fibrous structure according to Claim 6 wherein the active agent is selected from the group consisting of: skin benefit agents, medicinal agents, lotions, fabric care agents, dishwashing agents, carpet care agents, surface care agents, hair care agents, air care agents, and mixtures thereof.

13. The water-soluble fibrous structure according to Claim 1 wherein the bittering agent is selected from the group consisting of: denatonium chloride, denatonium citrate, denatonium saccharide, denatonium carbonate, denatonium acetate, denatonium benzoate, and mixtures thereof.

14. The water-soluble fibrous structure according to Claim 1 wherein the pungent agent is selected from the group consisting of: capsicinoids; vanillyl ethyl ether; vanillyl propyl ether; vanillyl butyl ether; vanillin propylene; glycol acetal; ethylvanillin propylene glycol acetal; capsaicin; gingerol; 4-(1-menthoxymethyl)-2-(3'-rnethoxy-4'-hydroxy-phenyl)-1, 3-dioxolane; pepper oil; pepper oleoresin; ginger oleoresin; nonylic acid vanillylamide; jamboo oleoresin; Zanthoxylum piperitum peel extract; sanshool; sanshoamide; black pepper extract; chavicine; piperine; spilanthol; and mixtures thereof.

15. The water-soluble fibrous structure according to Claim 1 wherein the emetic agent comprises ipecac.

16. The water-soluble fibrous structure according to Claim 1 wherein the active agent is present in at least one of the plurality of water-soluble fibrous elements.

17. The water-soluble fibrous structure according to Claim 1 wherein the deterrent agent is present in the water-soluble fibrous structure at a level of at least 10ppb after one month at 25°C and 60% relative humidity.

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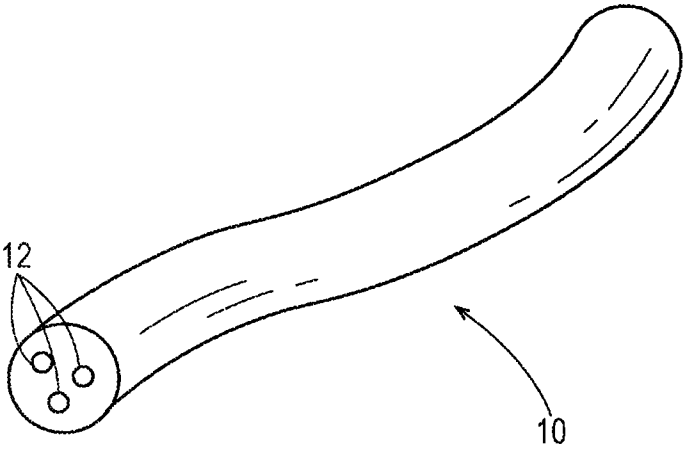

Fig. 1

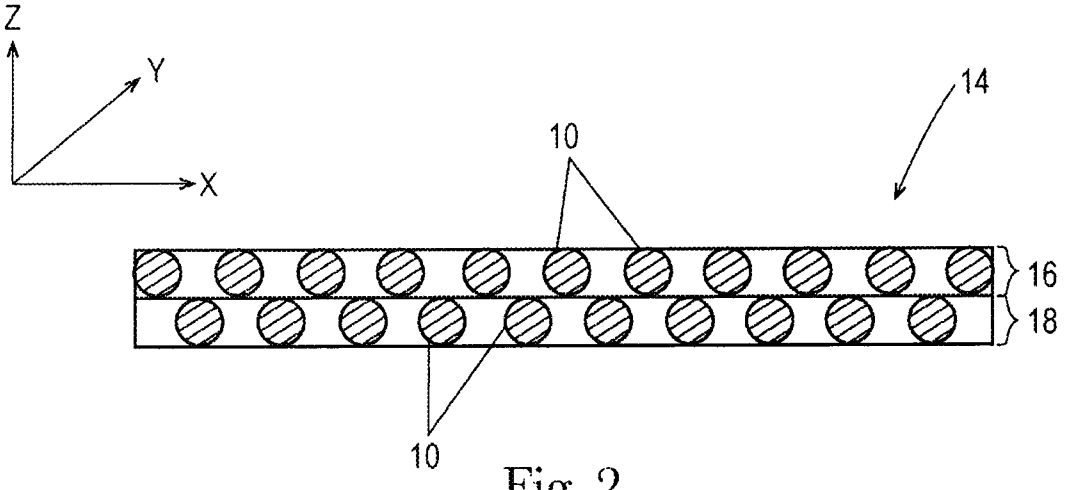

Fig. 2

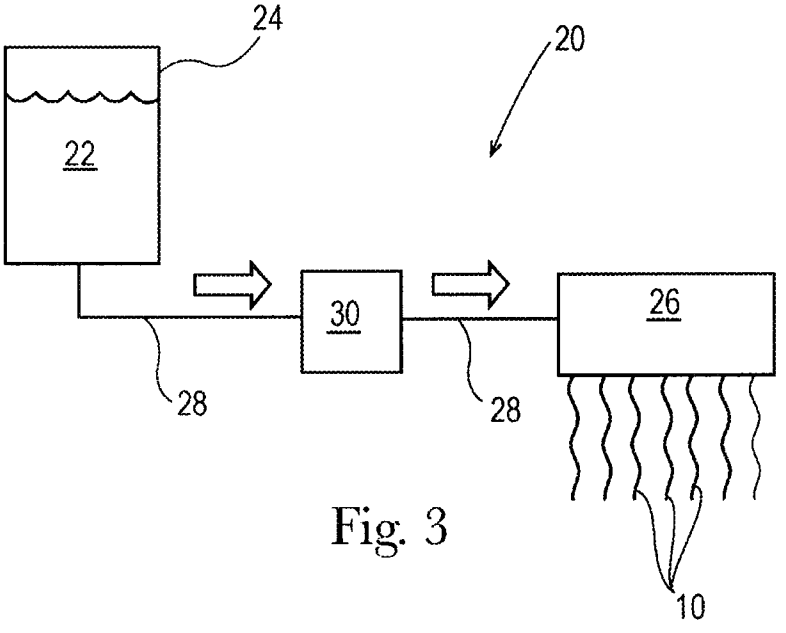

Fig. 3

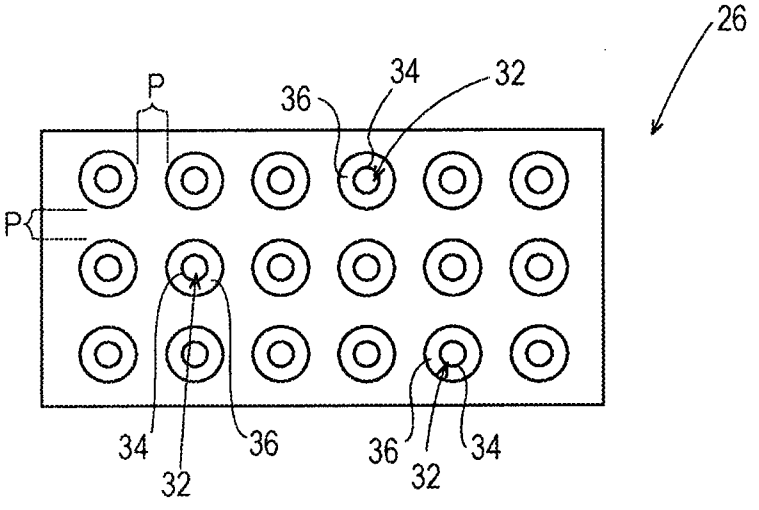

Fig. 4

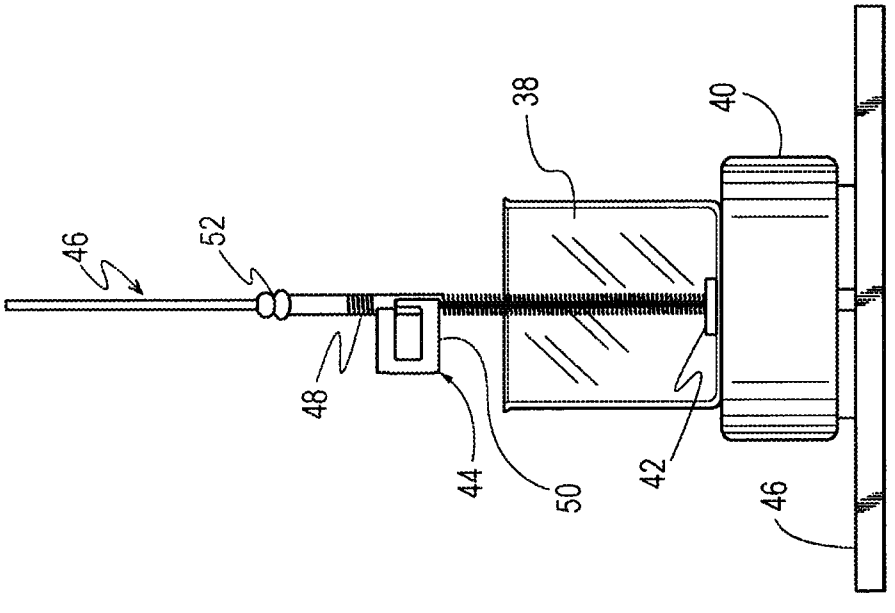

Fig. 5

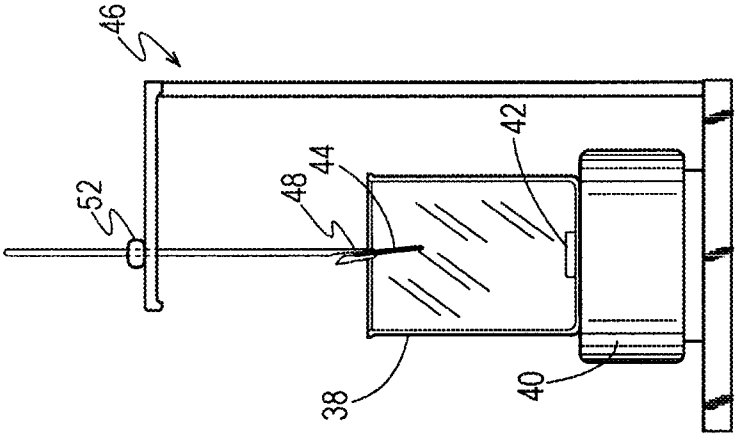

Fig. 6

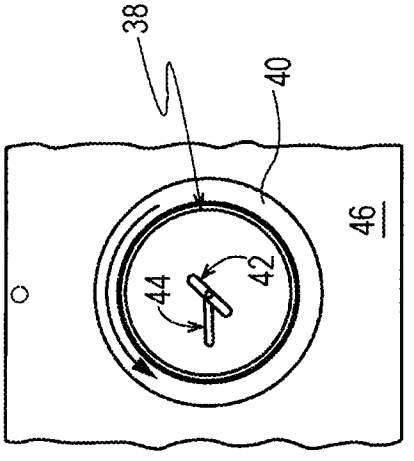

Fig. 7