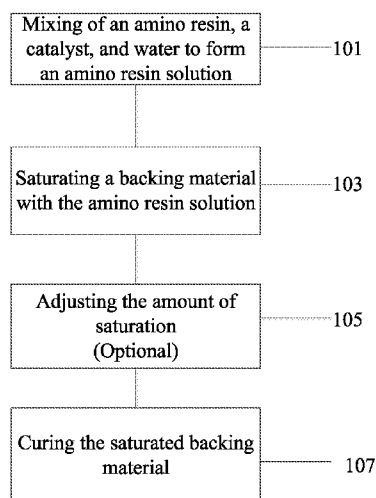




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(54) Title: AMINO RESIN TREATED BACKING MATERIAL, COATED ABRASIVE ARTICLES INCORPORATING SAME AND PROCESS OF MAKING THE SAME



(57) Abstract: This invention relates an amino resin treated backing material comprising a backing material impregnated with an amino resin comprising an alkylated trimethylol melamine obtained by reaction of trimethylol melamine with alkanol, coated abrasive article comprising the same, and methods of making and using said amino resin composition and coated abrasive articles. The claimed processes and systems related to use and manufacturing of coated abrasive articles are improved and cost effective.

FIG. 1



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**AMINO RESIN TREATED BACKING MATERIAL, COATED ABRASIVE ARTICLES
INCORPORATING SAME AND PROCESS OF MAKING THE SAME**

FIELD OF THE DISCLOSURE

The present invention relates to an amino resin treated fabric composition, abrasive articles including the same, and methods of making and using the amino resin treated fabric composition and abrasive articles.

BACKGROUND

DESCRIPTION OF THE RELATED ART

Coated abrasive articles are used in a variety of industrial and domestic applications. Coated abrasive articles typically include a backing substrate, upon which is disposed an abrasive layer. The abrasive layer is typically comprised of a “make coat” of binder material that is applied as a layer disposed on one side of the backing material, which then has abrasive particles disposed upon the make coat. A “size coat” layer comprising a second binder is then applied over the make coat and abrasive particles. Optionally, coated abrasive articles can further comprise a “supersize coat” covering the abrasive layer. A supersize coat typically includes grinding aids and/or anti-loading materials.

Alternately, an abrasive layer can be a “slurry coat”, where abrasive particles are dispersed within the binder material to form an abrasive slurry, and the slurry is then applied to the backing material.

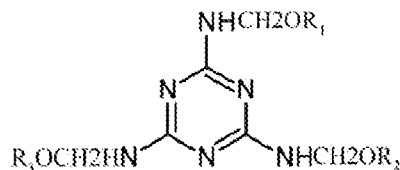
Coated abrasive articles can also comprise one or more layers applied to a backing material prior to application of an abrasive layer, including a “back size” layer (i.e., a coating applied on the side of the backing material opposite the side having the abrasive layer), a pre-size layer, a tie layer (i.e., a coating between the abrasive layer and the major surface of the backing to which the abrasive layer is secured), and/or a saturant. Optionally, the backing may further comprise a sub-size treatment. Sub size is similar to a saturated except that it is applied to a previously treated backing.

Conventional backing layers typically include various types of resins (e.g., polyvinyl alcohol, starch, latex, phenolic resins, and urea formaldehyde resins); however, all of these treatment suffer from various limitations, such as inadequate adhesion between the various layers, poor heat resistance, poor wear resistance, susceptibility to degradation due to the presence of solvents or elevated curing temperatures. Further, conventional backing treatments can emit various volatile compounds that can impart undesirable porosity to the abrasive layer, act as contaminants, or interfere with curing of the abrasive layer.

Manufactures are sensitive to reducing costs while still seeking to maintain or improve abrasive performance, thus there continues to be a demand for improved and cost effective processes and systems related to use and manufacturing of coated abrasive articles.

BRIEF DESCRIPTION

An embodiment provides an amino resin treated backing material, comprising:
an amino resin comprising a modified melamine formaldehyde resin having a formula

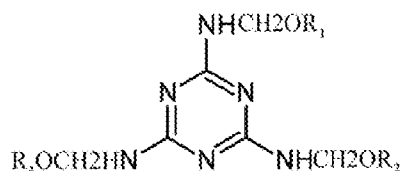


- 5 wherein R_1 , R_2 , R_3 each represents an independent substituent selected from hydrogen and alkyl groups having one to four carbon atoms; and
a backing material, wherein said backing material is impregnated with said amino resin.

- An embodiment also provides another amino resin treated backing material, comprising:
an amino resin comprising an alkylated trimethylol melamine obtained by reaction of trimethylol
10 melamine with alkanol; and
a backing material, wherein said backing material is impregnated with said amino resin.

An embodiment also provides a coated abrasive article comprising:
an amino resin treated backing material according to claim 1 or 2, and
an abrasive layer disposed on the amino resin treated backing material.

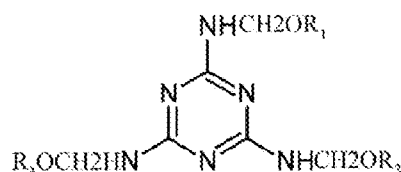
- 15 An embodiment provides another coated abrasive article comprising:
an amino resin treated backing material impregnated with a cured modified melamine formaldehyde resin having the formula:



- wherein R_1 , R_2 , R_3 each represents an independent substituent selected from hydrogen and alkyl
20 groups having one to four carbon atoms; and
an abrasive layer disposed on the amino resin treated backing material.

An embodiment further provides a process of making an amino resin treated backing material comprising:

- mixing water, catalyst, and a modified melamine formaldehyde resin to form an amino resin solution,
25 saturating a backing material with said amino resin solution to form a saturated backing material; and
curing said saturated backing material to form the amino resin treated backing material,
wherein the modified melamine formaldehyde resin has the formula



wherein R_1 , R_2 , R_3 each represents an independent substituent selected from a hydrogen or an alkyl group having one to four carbon atoms.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The present disclosure may be better understood, and its numerous features and advantages made apparent to those skilled in the art by referencing the accompanying drawings.

FIG. 1 is an illustration of a flowchart of an embodiment of a method of making a treated fabric backing according to the present invention.

10 FIG. 2 is an illustration of a schematic of an embodiment of a method of making a treated backing fabric according to the present invention.

FIG. 3 is an illustration of a cross-section of an embodiment of a coated abrasive according to the present invention.

FIG. 4 is an illustration of a cross-section of an embodiment of a coated abrasive according to the present invention.

15 FIG. 5 is a graph comparing the storage modulus (G') of amino resin solution samples with catalyst and without catalyst as a function of temperature.

FIG. 6 is a graph of body retention test data of inventive embodiments of amino resin treated polyester specimens.

20 FIG. 7 is a graph of body retention test data of comparative phenolic resin treated polyester specimens.

FIG. 8 is a photograph of the edge of an amino resin treated fabric embodiment showing the fabric edge is smooth and straight.

FIG. 9 is a photograph of the edge of a comparative phenolic resin treated fabric showing the fabric edge is puckered and curved.

25 The use of the same reference symbols in different drawings indicates similar or identical items.

DETAILED DESCRIPTION

The following description, in combination with the figures, is provided to assist in understanding the teachings disclosed herein. The following discussion will focus on specific
30 implementations and embodiments of the teachings. This focus is provided to assist in describing the teachings and should not be interpreted as a limitation on the scope or applicability of the teachings.

The term “averaged,” when referring to a value, is intended to mean an average, a geometric mean, or a median value. As used herein, the terms “comprises,” “comprising,” “includes,” “including,” “has,” “having,” or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a process, method, article, or apparatus that comprises a list of features is not necessarily limited only to those features but can include other features not expressly listed or inherent to such process, method, article, or apparatus. As used herein, the phrase “consists essentially of” or “consisting essentially of” means that the subject that the phrase describes does not include any other components that substantially affect the property of the subject.

Further, unless expressly stated to the contrary, “or” refers to an inclusive-or and not to an exclusive-or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

The use of “a” or “an” is employed to describe elements and components described herein. This is done merely for convenience and to give a general sense of the scope of the invention. This description should be read to include one or at least one and the singular also includes the plural, or vice versa, unless it is clear that it is meant otherwise.

Further, references to values stated in ranges include each and every value within that range. When the terms “about” or “approximately” precede a numerical value, such as when describing a numerical range, it is intended that the exact numerical value is also included. For example, a numerical range beginning at “about 25” is intended to also include a range that begins at exactly 25. Moreover, it will be appreciated that references to values stated as “at least about,” “greater than,” “less than,” or “not greater than” can include a range of any minimum or maximum value noted therein.

As used herein, the phrase “average particle diameter” can be reference to an average, mean, or median particle diameter, also commonly referred to in the art as D50.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The materials, methods, and examples are illustrative only and not intended to be limiting. To the extent not described herein, many details regarding specific materials and processing acts are conventional and can be found in textbooks and other sources within the coated abrasive arts.

Referring now to the figures, FIG. 1 illustrates a flow diagram of an embodiment of a process for making an amino resin treated backing material. During step 101, mixing of an amino resin, a catalyst, and water occurs to form an amino resin solution. During step 103, a backing material is saturated (also referred to herein as “impregnated”) with the amino resin solution. Optionally, adjusting the amount of saturation (i.e., adjusting the amount of add on amino resin weight) can occur in step 105. During step 107, curing, at least partially to fully, of the saturated backing material (i.e.,

curing at least partially to fully the add on amino resin) occurs to form an amino resin treated backing material.

Referring to FIG. 2, a process 200 for making an amino resin treated backing material is shown. A backing material 201 can be immersed in an amino resin solution 203. The saturated
5 backing material 205 can be manipulated to adjust the amount of saturation of the backing material (i.e., adjust the amount of amino resin that the backing material contains), such as by squeezing the saturated backing material between a pair of rollers 207. The saturation-adjusted pre-cured backing material 209 can be directed into an oven 211 (such as a multi-stage oven) to at least partially to fully
10 cure the amino resin and form an amino resin treated backing material 215. The amino resin treated backing material can be stored for later use, such as by winding into a roll 217, or alternatively, be subjected to further processing steps to form a coated abrasive article.

Preparation of Amino Resin Solution

All the ingredients of the amino resin solution are thoroughly mixed together. Mixing can be conducted using high shear conditions, moderate shear conditions, low shear conditions, or
15 combinations thereof. Typically, mixing occurs until the ingredients are thoroughly mixed.

During mixing of the amino resin solution ingredients, the ingredients may be added to the amino resin solution one by one, in batches, or all at once. Typically the ingredients are added one by one to the amino resin solution. If the ingredients are added one by one or in batches, the amino resin solution can be agitated for a period of time until the ingredient has sufficiently mixed into the amino
20 resin solution. Typical agitation times range from about 1 minute to about 2 hours, depending on the ingredient or ingredients being added to the amino resin solution.

The temperature of the amino resin solution can be adjusted if desired during mixing. The temperature of the amino resin solution during mixing can be in a range of about 15°C to about 45°C, such as about 20°C to about 25°C. The pH of the amino resin solution can be adjusted during mixing.
25 The pH can be adjusted by the addition of an acid, a base, a buffer solution, or a combination thereof if desired. The pH of the amino acid resin solution is typically close to neutral, but can be acidic or basic, such as in a range of about 3 pH to about 9pH.

The amount of the amino resin, catalyst, and water can be adjusted to control the viscosity of the amino resin solution. The viscosity of the amino resin solution can be monitored as it is being
30 prepared. In an embodiment, the viscosity of the amino resin solution is adjusted to be within a particular range. In an embodiment, the viscosity of the amino resin solution is in a range of about 10 cps to about 200 cps prior to addition of the catalyst to the amino resin solution. After the addition of the catalyst, the amino resin solution can have a viscosity in a range of about 10 cps to about 450 cps.

In an embodiment, the amino resin solution has a composition that can include:
35 from about 30 wt% to about 94 wt% amino resin; from about 0.05 wt% to about 5 wt% catalyst; and

the remainder is water, wherein the percentages are based on a total weight of the amino resin solution and all the percentages of the ingredients add up to 100 wt%. Optionally, from about 0.1 wt% to about 5 wt% of additives can also be added to the amino resin solution. If one or more additives is included, the amount of water can be adjusted so that the total amounts of the ingredients in the amino resin solution add up to 100 wt%.

In an embodiment, the total amount of amino resin in the amino resin solution can be not less than about 30 wt%, not less than about 35 wt%, not less than about 40 wt%, not less than about 45 wt%, not less than about 50 wt%, not less than about 55 wt%, not less than about 60 wt%, not less than about 65 wt%, not less than about 70 wt%, or not less than about 75 wt%. In another embodiment, the amount of amino resin in the amino resin solution can be not greater than about 94 wt%, not greater than about 90 wt%, not greater than about 85 wt%, or not greater than about 80 wt%. The amount of amino resin in the amino resin solution can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the amount of amino resin included in the amino resin solution can be in the range of not less than about 50 wt% to not greater than about 94 wt%.

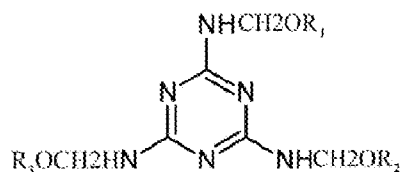
In an embodiment, the total amount of catalyst in the amino resin solution can be not less than about 0.05 wt%, not less than about 0.075 wt%, not less than about 0.1 wt%, not less than about 0.2 wt%, not less than about 0.3 wt%, not less than about 0.4 wt%, not less than about 0.5 wt%, not less than about 0.6 wt%, not less than about 0.7 wt%, not less than about 0.8 wt%, not less than about 0.9 wt%, or not less than about 1.0 wt%. In another embodiment, the amount of catalyst in the amino resin solution can be not greater than about 5 wt%, not greater than about 4 wt%, not greater than about 3 wt%, not greater than about 2.5 wt%, not greater than about 2.25 wt%, or not greater than about 2.0 wt%. The amount of catalyst in the amino resin solution can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the amount of catalyst included in the amino resin solution can be in the range of not less than about 0.8 wt% to not greater than about 2.2 wt%.

The amount of water in the amino resin solution can be adjusted as desired. In an embodiment, the total amount of water in the amino resin solution can be not less than about 1 wt%, not less than about 5 wt%, not less than about 10 wt%, or not less than about 15 wt%. In another embodiment, the amount of water in the amino resin solution can be not greater than about 70 wt%, not greater than about 60 wt%, not greater than about 50 wt%, not greater than about 40 wt%, not greater than about 30 wt%, or not greater than about 20 wt%. The amount of water in the amino resin solution can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the amount of water included in the amino resin solution can be in the range of not less than about 1 wt% to not greater than about 70 wt%.

In an embodiment, the amino resin solution can have a weight ratio of catalyst to amino resin in a range from about 1:1000 to about 1:16. In an embodiment, the weight ratio of catalyst to amino resin can be at least about 1:1000, such as at least about 1:800, at least about 1:500, at least about 1:200, at least about 1:100, at least about 1:90, at least about 1:85, or even at least about 1:80. In an embodiment, the weight ratio of catalyst to amino resin can be not greater than about 1:16, such as not greater than about 1:20, not greater than about 1:25, or not greater than about 1:30. The amount of water in the amino resin solution can be within a range comprising any pair of the previous upper and lower limits. In an embodiment, the amino resin solution can have a weight ratio of catalyst to amino resin in a range from about 1:800 to about 1:32.

10 Amino Resin

Suitable amino resins for use in the amino resin solution can include modified or blocked melamine formaldehyde resins. In an embodiment, the amino resin is an alkylated trimethylol melamine resin (hereinafter "ATMM"). In an embodiment, the amino resin can have formula

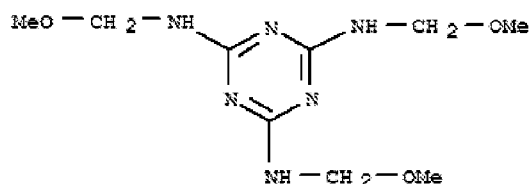


15 wherein R1, R2, R3 each represents an independent substituent selected from a hydrogen or an alkyl group having one to four carbon atoms to form an amino resin solution.

In an embodiment, R1, R2, and R3 are equal hydrogen. In another embodiment, R1, R2, and R3 are equal to a methyl group. In another embodiment, R1, R2, and R3 are equal to an ethyl group. In another embodiment, R1, R2, and R3 are equal to an n-propyl group. In another embodiment, R1, R2, and R3 are equal to an isopropyl group. In another embodiment, R1, R2, and R3 are equal to an n-butyl group. In another embodiment, R1, R2, and R3 are equal to a 2-butyl group. In another embodiment, R1, R2, and R3 are equal to an isobutyl group. R1, R2, and R3 can be the same, different, or combinations thereof.

It will be appreciated that the alkylated trimethylol melamine can be obtained by reaction of (i.e., is the reaction product of) a trimethylol melamine with an alkanol. In an embodiment, the alkanol can include 1 to 4 carbon atoms. In a specific embodiment, the alkanol is a methanol. The reaction can be conducted in an aqueous solution.

In a specific embodiment, the modified melamine formaldehyde resin is 1,3,5-Triazine-2,4,6-triamine,N2,N4,N6-tris(methoxymethyl), chemical structure shown below.



Catalyst

The amino resin solution can include a catalyst. The catalyst can be a single compound or a mixture of compounds. In an embodiment, suitable catalyst compounds include substituted
 5 or unsubstituted alkyl acids, or combinations thereof. In another embodiment, a catalyst can include, or be selected from, alkyl phosphoric acids, alkyl sulfonic acids, or combinations thereof. In an embodiment, a catalyst can comprise phosphoric acid, alkyl acid phosphates, amine blocked alkyl benzene sulfonic acid, hydrochloric acid, naphthalene sulfonic acid, alkyl phenyl phosphate, alkyl benzene sulfonic acid, blocked para-toluene sulfonic acid (p-TSA), or a combination thereof.

10 Water

In accordance with an embodiment, the amino resin solution can include water. Water can be tap water, distilled water, deionized water, or combinations thereof.

Saturating the Backing Material

A backing material can be saturated with amino resin solution (also referred to herein as being
 15 “impregnated” with amino resin solution) by any suitable manner that applies a sufficient amount of amino resin solution so that the backing material becomes thoroughly soaked with the amino resin solution. In an embodiment, saturation can be accomplished by dipping, spraying, submerging, coating, or washing the backing material with or in the amino resin solution, or combinations thereof. The saturation can occur as a single step or multiple steps, such as multiple dipping or multiple
 20 spraying of the backing material with the amino resin solution. In a specific embodiment, the backing material is dipped into an amino resin solution. In another embodiment a backing material is sprayed with an amino resin solution.

Amount of Saturation – Add-on weight

The amount of amino resin solution that saturates the backing material (i.e., the amount of
 25 amino resin solution that adheres to and/or is absorbed by the backing material) is also known as the “add-on” weight of the amino resin solution. The amount of saturation can be expressed as a percentage of the original weight of the backing material. For example, if the dry backing material weighs 100 g/m² and after saturation weighs 150 g/m², the cloth would be 50% saturated. Alternatively, the amount of saturation can be expressed as an amount of add-on weight of the amino
 30 resin solution. For example, if the dry backing material weighs 100 g/m² and after saturation weighs 150 g/m², the amount of saturation would be expressed as 50 g/m² of add-on weight of amino resin

solution. The amount of saturation can also be expressed as a combination of percentage of the original weight of the backing material and add-on weight.

In an embodiment, the amount of saturation of the backing material can be in a range of not less than about 1 wt%, not less than about 2.5 wt%, not less than about 5 wt%, not less than about 10 wt%, not less than about 12.5 wt%, not less than about 15 wt%, not less than about 20 wt%, not less than about 25 wt%, not less than about 30 wt%, or not less than about 35 wt%. In another embodiment, the amount of saturation of the backing material can be not greater than about 500 wt%, not greater than about 400 wt%, not greater than about 300 wt%, not greater than about 200 wt%, not greater than about 100 wt%, not greater than about 90 wt%, not greater than about 80 wt%, not greater than about 70 wt%, not greater than about 60 wt%, not greater than about 50 wt%, or not greater than about 40 wt%. The amount of saturation of the backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the amount of saturation of the backing material can be in the range of not less than about 1 wt% to not greater than about 500 wt%.

In an embodiment, the amount of saturation of the backing material can be in a range of about 10 g/m² to about 300 g/m² of backing material. In an embodiment, the amount of saturation of the backing material (i.e., wet add-on amino resin solution weight) can be at least about 10 g/m², such as at least about 50 g/m², at least about 100 g/m², at least about 150 g/m², at least about 200 g/m², or at least about 250 g/m². In an embodiment, the amount of saturation of the backing material can be in a range of not greater than about 300 g/m², such as not greater than about 250 g/m², not greater than about 200 g/m², not greater than about 150 g/m², not greater than about 100 g/m², or not greater than about 50 g/m². The amount of saturation of the backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the amount of saturation of the backing material can be in the range of not less than about 10 g/m² to about 300 g/m².

Adjusting Saturation

As illustrated in FIG. 1 and FIG. 2, the amount of amino resin solution saturation of the backing material can be adjusted. Adjusting the saturation of the amino resin solution can be accomplished by any method or mechanism that does not overly degrade the backing material and that re-applies or removes a desired amount of amino resin solution so that the backing material has a desired amount of saturation. Adjusting the amount of amino resin solution can be accomplished in a single or multiple steps. Adjusting the amount of amino resin solution can include pressing, squeezing, brushing, squeegeeing, blowing, dabbing, blotting, shaking, combinations thereof, or the like. In a specific embodiment, the saturated backing material can be squeezed, such as between a pair of rollers to adjust the saturation of the saturated backing material.

Backing Material

The backing material can be organic material, inorganic material, natural material, synthetic material, or combinations thereof. The backing can be flexible or rigid. The backing material can be made of a single material or combination of various materials. In an embodiment, a particular backing material is a polyester material. In an embodiment, a backing material is or includes a polyester fabric. A polyester fabric can be a fabric blend that includes polyester fibers and one or more other types of fibers. In an embodiment, the backing material can be a cloth (e.g., cloth made from fibers or yarns comprising polyester, nylon, silk, cellulose fiber, cotton, viscose, polyamide, polyamines, poly-cotton, rayon, or combinations thereof). In an embodiment, the backing material can be a composite backing material that comprises a polyester material and one or more other backing materials, such as paper; vulcanized paper; vulcanized rubber; vulcanized fiber; nonwoven materials, thermoplastic film, such as a polyethylene terephthalate (PET) film, a network of fibers, for example a mat, a felt, a fabric or a knit of natural or synthetic fibers, including mineral fibers, glass fibers, polymer fibers, plant fibers, or combinations thereof; or any treated version thereof. Cloth backing materials can be woven, stitch bonded, combed, carded, filament, or any combination thereof. The backing material can be a finished cloth, unfinished cloth (i.e. "grey cloth"), or a combination thereof. In a particular embodiment, the backing material is an unfinished polyester fabric. In a particular embodiment, the backing material is a woven polyester fabric. In another specific embodiment, the backing material is a polyester blend fabric of 90% polyester and 10% cotton fibers.

In accordance with an embodiment, the backing material prior to saturation can include at least about 50 wt% polyester, such as at least about 60 wt% polyester, at least about 70 wt% polyester, at least about 75 wt% polyester, at least about 80 wt% polyester, at least about 90 wt% polyester, or even at least about 95 wt% polyester. In an embodiment, the backing material prior to saturation can include not greater than about 95 wt% polyester, such as not greater than about 90 wt% polyester, not greater than about 80 wt% polyester, not greater than about 75 wt% polyester, not greater than about 70 wt% polyester, or even not greater than about 60 wt% polyester, not greater than about 50 wt% polyester. The amount of backing material prior to saturation can be within a range comprising any pair of the previous upper and lower limits.

Drying/Curing

After saturation of the backing material with amino resin solution, and any optional adjustment of the amount of saturation of the backing material, the saturated or saturation adjusted pre-cure backing material can undergo curing to form completed amino resin treated backing material. The completed amino resin treated backing material is impregnated with cured amino resin. Curing can be conducted in a single step or multiple steps. Curing can be accomplished by exposure to a heat source, such as a heating tunnel or oven, including a multi stage oven, or the like. Alternative heating sources can include exposure to infrared radiation lamps, or the like.

In an embodiment, the saturated backing material (or the adjusted saturation backing material) is cured at a particular temperature. The add-on amino resin saturating the backing material is cured. In an embodiment, the curing temperature is at least about 95°C, such as at least about 100 °C, such as at least about 110 °C, or at least about 125 °C. In an embodiment, the curing temperature is not
5 greater than about 175°C, such as not greater than about 170 °C, not greater than about 165 °C, not greater than about 160°C, not greater than about 155°C, or not greater than about 150 °C. The curing temperature of the backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the curing temperature can be in the range of not less than 100 °C to about 150 °C.

10 In accordance with an embodiment, the saturated backing material (or the adjusted saturation backing material) (i.e., the add-on amino resin solution saturating the backing material) can be cured to a particular degree. In an embodiment, the add-on amino resin solution saturating the backing material can be partially cured or completely cured. In a particular embodiment, the add-on amino resin solution can be cured to a degree that the previously saturated fabric is rendered tack free (i.e.,
15 not tacky, does not stick to fingers). In a specific embodiment, the saturated backing material is partially cured and not tacky to the touch. In another specific embodiment, the saturated backing material is completely cured and not tacky to the touch. The amino resin treated material that is impregnated with partially cured or completely cured amino resin is not tacky to the touch.

In an embodiment, the backing material may be cured to a tack-free degree within a particular
20 amount of time. In an embodiment, the backing material may be cured to a tack-free degree within at least about 30 seconds, such as at least about 45 seconds, at least about 60 seconds, at least about 90 seconds, at least about 120 seconds, at least about 150 seconds, at least about 180 seconds, at least about 210 seconds, at least about 240 seconds, or even at least about 270 seconds. In an embodiment, the backing material may be cured to a tack-free degree within not greater than about 300 seconds,
25 such as not greater than about 270 seconds, not greater than about 240 seconds, not greater than about 210 seconds, not greater than about 180 seconds, not greater than about 150 seconds, not greater than about 120 seconds, not greater than about 90 seconds, not greater than about 60 seconds, or even not greater than about 45 seconds. The backing material can be cured to a tack-free degree within a particular amount of time within a range comprising any pair of the previous upper and lower limits.
30 In a particular embodiment, the backing material can be cured to a tack-free degree within a range of not less than 30 seconds to not greater than about 300 seconds.

It will be appreciated that the inventive saturated backing material embodiments can surprisingly and beneficially be cured at lower temperatures (such as approximately 50 °C lower) to a tack-free state and even to a completely cured state compared to conventional backing treatments.
35 The reduction in curing temperature produces a significant reduction in energy consumed, particularly over the extended curing times that are typically employed to assure complete curing of coated

abrasive articles (e.g., 20 hours). Further, the lower curing temperatures avoid thermal degradation of the backing material, thus helping prevent premature failure of coated abrasive articles that incorporate the amino resin treated coated abrasive.

Further, it is expected that the amino resin treated backing material impregnated with cured amino resin exhibits beneficial physical and abrasive performance properties.

Features of the article

An amino resin treated backing material formed in accordance with embodiments herein may enjoy particular beneficial features. In accordance with an embodiment, the amino resin treated backing material can have a particular tensile strength factor. The tensile strength factor can be defined as a ratio of the tensile strength of the amino resin treated backing material to the tensile strength of a conventionally treated backing material or an untreated backing material. Alternatively, the tensile strength factor can be defined as a percent increase compared to the tensile strength of a conventionally treated backing material or an untreated backing material.

In an embodiment, the tensile strength factor can be at least about 1.0, such as at least about 1.05, at least about 1.1, at least about 1.15, or at least about 1.2 of a conventionally treated backing material or an untreated backing material. In an embodiment, the tensile strength factor can be not greater than about 2.5, such as not greater than about 2.25, not greater than about 2.0, not greater than about 1.75, not greater than about 1.5, or not greater than about 1.4 of a conventionally treated backing material or an untreated backing material. The tensile strength factor of the amino resin treated backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the tensile strength factor of the amino resin treated backing material can be in a range of not less than 1.0 to not greater than about 2.5 of a conventionally treated backing material or an untreated backing material.

In an embodiment, the tensile strength factor can be at least about a 2.5% increase, such as at least about a 5% increase, at least about a 7.5% increase, at least about a 10% increase, or at least about a 12.5% increase in tensile strength of a conventionally treated backing material or an untreated backing material. In an embodiment, the tensile strength factor can be not greater than about a 100% increase, such as not greater than about a 75% increase, not greater than about a 50% increase, or not greater than about a 25% increase in tensile strength of a conventionally treated backing material or an untreated backing material. The tensile strength factor of the amino resin treated backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the tensile strength factor of the amino resin treated backing material can be in a range of not less than about a 2.5% increase to not greater than about a 100% increase of a conventionally treated backing material or an untreated backing material.

In accordance with an embodiment, the amino resin treated backing material can have a particular elongation rate factor. The elongation rate factor can be defined as a ratio of the elongation

rate of the amino resin treated backing material to the elongation rate of a conventionally treated backing material or an untreated backing material (lower elongation rate factor is better).

Alternatively, the elongation factor can be defined as a percent decrease compared to the elongation rate of a conventionally treated backing material or an untreated backing material. In accordance with an embodiment, the amino resin treated backing material can have a particular elongation factor that can be defined as a ratio of an elongation rate at 600 N of an amino resin treated backing material to a conventionally treated backing material or an untreated backing material. In an embodiment, the elongation factor can be not greater than 1.0, such as not greater than 0.95, not greater than 0.9, not greater than 0.85, not greater than 0.80, or not greater than 0.75. In an embodiment, the elongation factor can be not less than about 0.5, such as not less than about 0.4, or not less than about 0.3. The elongation rate factor of the amino resin treated backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the elongation rate factor of the amino resin treated backing material can be in a range of not greater than about 1.0 to not less than about 0.3 of a conventionally treated backing material or an untreated backing material.

In an embodiment, the elongation rate factor can be at least about a 2.5% decrease, such as at least about a 5% decrease, at least about a 7.5% decrease, at least about a 10% decrease, at least about a 12.5% decrease, at least about a 15% decrease, at least about a 17.5% decrease, or at least about a 20.0% decrease in elongation rate from a conventionally treated backing material or an untreated backing material. In an embodiment, the elongation rate factor can be not greater than about a 100% decrease, such as not greater than about a 75% decrease, or not greater than about a 50% decrease in elongation rate of a conventionally treated backing material or an untreated backing material. The elongation rate factor of the amino resin treated backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the elongation rate factor of the amino resin treated backing material can be in a range of not less than about a 2.5% decrease to not greater than about a 100% decrease of a conventionally treated backing material or an untreated backing material.

In an embodiment, the amino resin treated backing material can have a certain percentage of visually detectable bubbles. In an embodiment, the percentage of visually detectable bubbles can be from 5 % to 0% of the surface area of the amino resin treated making material. In a particular embodiment, the amino resin treated backing material is free of visually detectable bubbles.

In accordance with an embodiment, the amino resin treated backing material can have a particular body retention factor. The body retention factor can be defined as a ratio of the tensile strain of the amino resin treated backing material to the tensile strain of a conventionally treated backing material or an untreated backing material (lower body retention factor is better).

Alternatively, the body retention factor can be defined as a percent decrease compared to the tensile strain of a conventionally treated backing material or an untreated backing material.

In accordance with an embodiment, the amino resin treated backing material can have a particular body retention factor that can be defined as a ratio of maximum tensile strain at 500 N or 100N of an amino resin treated backing material to a conventionally treated backing material or an untreated backing material. In an embodiment, the body retention factor can be not greater than 1.0, such as not greater than 0.95, not greater than 0.9, not greater than 0.85, not greater than 0.80, or not greater than 0.75. In an embodiment, the body retention factor can be not less than about 0.6, such as not less than about 0.5, or not less than about 0.4. The body retention factor of the amino resin treated backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the body retention factor of the amino resin treated backing material can be in a range of not greater than about 1.0 to not less than about 0.4 of a conventionally treated backing material or an untreated backing material.

In an embodiment, the body retention factor can be at least about a 2.5% decrease, such as at least about a 5% decrease, at least about a 7.5% decrease, at least about a 10% decrease, at least about a 12.5% decrease, at least about a 15% decrease, at least about a 17.5% decrease, or at least about a 20.0% decrease in tensile strain from a conventionally treated backing material or an untreated backing material. In an embodiment, the body retention factor can be not greater than about a 100% decrease, such as not greater than about a 75% decrease, not greater than about a 50% decrease, or not greater than about a 40% decrease in tensile strain of a conventionally treated backing material or an untreated backing material. The body retention factor of the amino resin treated backing material can be within a range comprising any pair of the previous upper and lower limits. In a particular embodiment, the body retention factor of the amino resin treated backing material can be in a range of not less than about a 12.5% decrease to not greater than about a 100% decrease of a conventionally treated backing material or an untreated backing material.

Preparation of a Coated Abrasive

The amino resin treated backing material can be used to make a coated abrasive article. In an embodiment, an abrasive layer is disposed on the amino resin treated backing material. Optionally, a size coat, a supersize coat, a back coat or any other number of compliant or intermediary layers known in the art of making a coated abrasive article can be applied to the amino resin treated backing to construct a coated abrasive article.

Abrasive Layer

An abrasive layer can comprise a make coat or an abrasive slurry. The make coat or abrasive slurry can comprise a plurality of abrasive particles, also referred to herein as abrasive grains, retained by a polymer binder composition. The polymer binder composition can be an aqueous composition. The polymer binder composition can be a thermosetting composition, a radiation cured composition, or a combination thereof.

Abrasive Grains

Abrasive grains can include essentially single phase inorganic materials, such as alumina, silicon carbide, silica, ceria, and harder, high performance superabrasive grains such as cubic boron nitride and diamond. Additionally, the abrasive grains can include composite particulate materials. Such materials can include aggregates, which can be formed through slurry processing pathways that include removal of the liquid carrier through volatilization or evaporation, leaving behind green aggregates, optionally followed by high temperature treatment (i.e., firing) to form usable, fired aggregates. Further, the abrasive regions can include engineered abrasives including macrostructures and particular three-dimensional structures.

In an exemplary embodiment, the abrasive grains are blended with the binder formulation to form abrasive slurry. Alternatively, the abrasive grains are applied over the binder formulation after the binder formulation is coated on the backing. Optionally, a functional powder may be applied over the abrasive regions to prevent the abrasive regions from sticking to a patterning tooling. Alternatively, patterns may be formed in the abrasive regions absent the functional powder.

The abrasive grains may be formed of any one of or a combination of abrasive grains, including silica, alumina (fused or sintered), zirconia, zirconia/alumina oxides, silicon carbide, garnet, diamond, cubic boron nitride, silicon nitride, ceria, titanium dioxide, titanium diboride, boron carbide, tin oxide, tungsten carbide, titanium carbide, iron oxide, chromia, flint, emery. For example, the abrasive grains may be selected from a group consisting of silica, alumina, zirconia, silicon carbide, silicon nitride, boron nitride, garnet, diamond, co-fused alumina zirconia, ceria, titanium diboride, boron carbide, flint, emery, alumina nitride, and a blend thereof. Particular embodiments have been created by use of dense abrasive grains comprised principally of alpha-alumina.

The abrasive grain may also have a particular shape. An example of such a shape includes a rod, a triangle, a pyramid, a cone, a solid sphere, a hollow sphere, or the like. Alternatively, the abrasive grain may be randomly shaped.

In an embodiment, the abrasive grains can have an average grain size not greater than 800 microns, such as not greater than about 700 microns, not greater than 500 microns, not greater than 200 microns, or not greater than 100 microns. In another embodiment, the abrasive grain size is at least 0.1 microns, at least 0.25 microns, or at least 0.5 microns. In another embodiment, the abrasive grains size is from about 0.1 microns to about 200 microns and more typically from about 0.1 microns to about 150 microns or from about 1 micron to about 100 microns. The grain size of the abrasive grains is typically specified to be the longest dimension of the abrasive grain. Generally, there is a range distribution of grain sizes. In some instances, the grain size distribution is tightly controlled.

Binder - Make Coat

The binder of the make coat or the size coat may be formed of a single polymer or a blend of polymers. For example, the binder may be formed from epoxy, acrylic polymer, or a combination thereof. In addition, the binder may include filler, such as nano-sized filler or a combination of nano-

sized filler and micron-sized filler. In a particular embodiment, the binder is a colloidal binder, wherein the formulation that is cured to form the binder is a colloidal suspension including particulate filler. Alternatively, or in addition, the binder may be a nanocomposite binder including sub-micron particulate filler.

5 The binder generally includes a polymer matrix, which binds abrasive grains to the backing or compliant coat, if present. Typically, the binder is formed of cured binder formulation. In one exemplary embodiment, the binder formulation includes a polymer component and a dispersed phase.

 The binder formulation may include one or more reaction constituents or polymer constituents for the preparation of a polymer. A polymer constituent may include a monomeric
10 molecule, a polymeric molecule, or a combination thereof. The binder formulation may further comprise components selected from the group consisting of solvents, plasticizers, chain transfer agents, catalysts, stabilizers, dispersants, curing agents, reaction mediators and agents for influencing the fluidity of the dispersion.

 The polymer constituents can form thermoplastics or thermosets. By way of example, the
15 polymer constituents may include monomers and resins for the formation of polyurethane, polyurea, polymerized epoxy, polyester, polyimide, polysiloxanes (silicones), polymerized alkyd, styrene-butadiene rubber, acrylonitrile-butadiene rubber, polybutadiene, or, in general, reactive resins for the production of thermoset polymers. Another example includes an acrylate or a methacrylate polymer constituent. The precursor polymer constituents are typically curable organic material (i.e., a polymer
20 monomer or material capable of polymerizing or crosslinking upon exposure to heat or other sources of energy, such as electron beam, ultraviolet light, visible light, etc., or with time upon the addition of a chemical catalyst, moisture, or other agent which cause the polymer to cure or polymerize). A precursor polymer constituent example includes a reactive constituent for the formation of an amino polymer or an aminoplast polymer, such as alkylated urea-formaldehyde polymer, melamine-formaldehyde polymer, and alkylated benzoguanamine-formaldehyde polymer; acrylate polymer
25 including acrylate and methacrylate polymer, alkyl acrylate, acrylated epoxy, acrylated urethane, acrylated polyester, acrylated polyether, vinyl ether, acrylated oil, or acrylated silicone; alkyd polymer such as urethane alkyd polymer; polyester polymer; reactive urethane polymer; phenolic polymer such as resole and novolac polymer; phenolic/latex polymer; epoxy polymer such as bisphenol epoxy
30 polymer; isocyanate; isocyanurate; polysiloxane polymer including alkylalkoxysilane polymer; or reactive vinyl polymer. The binder formulation may include a monomer, an oligomer, a polymer, or a combination thereof. In a particular embodiment, the binder formulation includes monomers of at least two types of polymers that when cured may crosslink. For example, the binder formulation may include epoxy constituents and acrylic constituents that when cured form an epoxy/acrylic polymer.

35 Size Coat

The coated abrasive article can comprise a size coat overlying the abrasive layer. The size coat can be the same as or different from the polymer binder composition used to form the abrasive layer. The size coat can comprise any conventional compositions known in the art that can be used as a size coat. In an embodiment, the size coat comprises a conventionally known composition

overlying the polymer binder composition of the abrasive layer. In another embodiment, the size coat comprises the same ingredients as the polymer binder composition of the abrasive layer. In a specific embodiment, the size coat comprises the same ingredients as the polymer binder composition of the abrasive layer and one or more hydrophobic additives. In a specific embodiment, the hydrophobic additive can be a wax, a halogenated organic compound, a halogen salt, a metal, or a metal alloy.

Supersize Coat

The coated abrasive article can comprise a supersize coat overlying the size coat. The supersize coat can be the same as or different from the polymer binder composition or the size coat composition. The supersize coat can comprise any conventional compositions known in the art that can be used as a supersize coat. In an embodiment, the supersize coat comprises a conventionally known composition overlying the size coat composition. In another embodiment, the supersize coat comprises the same ingredients as at least one of the size coat composition or the polymer binder composition of the abrasive layer. In a specific embodiment, the supersize coat comprises the same composition as the polymer binder composition of the abrasive layer or the composition of the size coat plus one or more grinding aids.

Suitable grinding aids can be inorganic based; such as halide salts, for example sodium cryolite, and potassium tetrafluoroborate; or organic based, such as sodium lauryl sulphate, or chlorinated waxes, such as polyvinyl chloride. In an embodiment, the grinding aid can be an environmentally sustainable material.

Illustrated in FIG. 3 is an embodiment of a coated abrasive article 300, commonly called a “coated abrasive.” The coated abrasive 300 includes a backing 301 and an abrasive layer 303 disposed on the backing 301. The abrasive layer 303 comprises a plurality of abrasive particles 305 that are retained by a polymer binder composition 307. The polymer binder composition 307 is commonly called a “make coat” where the abrasive particles 305 are disposed on the surface 309 of the polymer binder composition and are partially embedded in the polymer binder composition. The coated abrasive 300 can also include a size coat 311 overlying the abrasive layer 303. Optionally, a supersize coat (not illustrated) can be overlying the size coat 311. Further, an adhesion promoting layer (not illustrated) can optionally be located between the backing 301 and the abrasive layer 303.

Illustrated in FIG. 4 is another embodiment of a coated abrasive article 400. The coated abrasive 400 includes a backing 401 and an abrasive layer 403 disposed on the backing 401. The abrasive layer 403 comprises a plurality of abrasive particles 405 dispersed within a polymer binder composition 407. The abrasive layer 403 is commonly called an “abrasive slurry coat” where the

abrasive particles 405 are dispersed within the polymer binder composition 407. The coated abrasive 400 can also include a size coat 409 overlying the abrasive layer 403. Optionally, a supersize coat (not illustrated) can be overlying the size coat 409. Further, an adhesion promoting layer (not illustrated) can optionally be located between the backing 401 and the abrasive layer 403.

5 Examples

Example 1: Forming an Amino Resin Treated Fabric Backing

An amino resin solution was prepared by mixing together the following ingredients:

80.0 parts by weight alkylated trimethylol melamine ("ATMM") amino resin
 18.9 parts by weight water
 1.1 parts by weight catalyst

The water was added to the amino resin and mixed to achieve a desired viscosity. The catalyst was then added to the mixture to form the amino resin solution. The solution was maintained in a temperature range of about 20-45 °C.

A polyester blend fabric, about 90% polyester and about 10% cotton, was then impregnated with the amino resin solution by submerging the fabric in the amino resin solution. The saturated fabric was subsequently passed through a pair of squeeze-off rolls at about 25 °C to squeeze out excess amino resin solution. The saturated fabric was passed through a heating tunnel to partially cure the amino resin. The heating tunnel had several heating zones having a temperature in a range of 125 °C to 150 °C and the residence time in the heating tunnel lasted from 0.5 minutes to 5 minutes. The amino resin (the "addon") was partially cured (i.e., not completely cured) and the amino resin impregnated fabric was not tacky to touch (i.e., the amino resin impregnated fabric did not stick to fingers). The partially cured amino resin treated fabric was then wound onto a roll and stored for subsequent processing to make coated abrasive articles.

Example 2: Catalyst Effect

An amino resin solution was prepared by mixing 80 parts by weight of alkylated trimethylol melamine (ATMM) amino resin with different amounts of catalyst and water as listed in Table 1. A polyester blend fabric, 90 wt% polyester and 10 wt% cotton, was saturated by submerging the fabric in the amino resin solution and then pressed to squeeze out excess solution. The weight of the add-on ATMM amino resin was 100 grams per square meter (gsm) of the fabric. The saturated fabric was then heated in an oven at 150 °C for 1min. The texture of the impregnated fabric was examined by visual inspection and hand touch. The observations are listed in Table 2.

Table 1 – Amino Resin Sample Solutions

Chemical	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Amino resin	80.0 wt%	80.0 wt%	80 wt%	80 wt%	80 wt%
Catalyst 4040	2.4 wt%	1.6 wt%	1.1 wt%	0.8 wt%	0.0 wt%
Water	17.6 wt%	18.4 wt%	18.9 wt%	19.2 wt%	20 wt%

Table 2 – Observations of Amino Resin Treated Fabric

Treated fabric	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
observation	Fabric is dry, with bubbles	Fabric is smooth, not tacky	Fabric is smooth, not tacky	Fabric is tacky	Fabric is very tacky

For Sample 1, the treated fabric had a dry surface with visible bubbles in the cured resin.

Samples 2 and 3 produced good results, where the treated fabric was smooth to the touch, not tacky, and did not have any visible bubbles. For Sample 4 the treated fabric was tacky to the touch and did not have any visible bubbles. For Sample 5 the treated fabric was very tacky to the touch and did not have any visible bubbles.

Example 3: Rheology testing and Reaction Temperature

Two amino resins solutions were prepared. The first amino resin solution included catalyst (“with catalyst”) and was comprised of:

- 10 80.0 parts by weight alkylated trimethylol melamine (“ATMM”) amino resin;
- 18.6 parts by weight water; and
- 1.4 parts by weight catalyst.

The second amino resin solution did not include catalyst (“without catalyst”) and was comprised of:

- 15 80.0 parts by weight alkylated trimethylol melamine (“ATMM”) amino resin and
- 20 parts by weight water.

Rheology testing was conducted on two samples each of the amino resin solution with catalyst (“with catalyst”) and without catalyst (“without catalyst”) by measuring the storage modulus (G’) as a function of temperature. The results are shown in FIG. 5. The data shows that as the temperature increases and the amino resin starts and continues to crosslink, the storage modulus increases. No significant difference was observed in the starting temperature of the crosslinking reaction between the amino resin solution with catalyst and the amino resin solution without catalyst. However, for the solution without catalyst, the storage modulus reached 1 MPa at approximately 150 °C. In contrast, for the solution with catalyst, the storage modulus reached 1 MPa at approximately 100 °C. This indicates that the rate of the crosslinking reaction of the amino resin solution with catalyst is much higher than the amino resin solution without the catalyst. Importantly and beneficially, the catalyst significantly reduced the reaction temperature required to achieve desired crosslinking, thus providing a significant reduction in the amount of time and energy required to cure the amino resin and produce the treated backing material.

30 Example 4 - Tensile strength and elongation testing

Tensile strength and elongation rate testing of a comparative treated fabric sample and an inventive treated fabric sample was conducted.

An inventive amino resins solution was prepared by mixing:

80.0 parts by weight alkylated trimethylol melamine ("ATMM") amino resin
18.9 parts by weight water
1.1 parts by weight catalyst

A comparative phenolic resin solution was prepared by mixing:

80.0 parts by weight phenolic resin
20.0 parts by weight water

A piece (gauge length 20 cm, width 5 cm) of polyester blend fabric (90 wt% polyester and 10 wt% cotton) was submerged in the inventive amino resin solution and pressed to squeeze out excess solution. The weight of the add-on amino resin was in a range of 45 to 50 grams per square meter (gsm) of fabric. The saturated fabric was then heated in an oven at about 105 °C for 17 hours to completely cure the amino resin and produce an amino resin treated fabric.

A comparative phenolic resin treated fabric was produced in the same manner by submerging a piece of polyester blend fabric in the comparative phenolic resin solution, squeezing out excess solution, and curing in an oven at the same time and temperature to produce a comparative phenolic resin treated fabric.

The inventive amino resin treated fabric and the comparative phenolic resin treated fabric were then soaked in water at room temperature for different periods of time. The tensile strength and elongation rate of the different treated fabrics was measured and is presented in Table 3 and Table 4, below.

Table 3 – Tensile Strength

Tensile strength (N, in warp direction)						
Soaking time in water	0 hr	0.5 hr	1 hr	2.5 hr	2 hr	3 hr
Phenolic Resin Sample	1986.31	1911.07	1965.48	1942.75	1956.37	1968.72
Amino Resin Sample	2268.99	2374.7	2436.02	2371.05	2427.65	2395.56
% difference	14.2 % increase	24.3 % increase	23.9 % increase	22.0 % increase	24.1 % increase	21.7 % increase

Table 4 – Elongation rate

Elongation rate (% , in warp direction) at 600 N						
Soaking time in water	0 hr	0.5 hr	1 hr	2.5 hr	2 hr	3 hr
Phenolic Resin Sample	1.29	1.82	1.88	1.78	1.77	1.85
Amino Resin Sample	0.98	1.14	1.16	1.16	1.2	1.18
% difference	24.0 % decrease	37.4 % decrease	38.3 % decrease	34.8 % decrease	32.2 % decrease	36.2 % decrease

The data shows that the amino resin treated polyester fabric has higher tensile strength than phenolic resin treated polyester fabric (at 600 N force). Amino resin treated polyester fabric has lower elongation rate (at 600 N force) than phenolic resin treated polyester fabric.

Example 5 - Body retention testing

Inventive amino resin treated fabric and comparative phenolic resin treated fabric was prepared as described in Example 5 above. Three specimens of the amino resin treated fabric and three specimens of phenolic resin treated fabric were subjected to body retention testing.

The body retention testing was conducted by clamping two opposite sides of a fabric specimen with two clamps so that the fabric specimen was strained in the warp direction. Testing speed was 50 mm/min.

Body retention is expressed as an average tensile strain after 10 cycles of elongation of the fabric with maximum loading force at 600 N. The results of the body retention test data for the amino resin treated fabric specimens and the phenolic resin treated fabric specimens are presented in FIG. 6 and FIG.7, respectively, and in Table 5, below.

A lower average tensile strain after 10 cycles of elongation force loading was observed for the amino resin treated fabric specimens as compared with the phenolic resin treated fabric specimens. Additionally, the amino resin treated fabric specimens had better body retention (i.e., recovered there original shape) after 10 cycles of stretching compared to the phenolic resin treated fabric specimens.

Table 5

	Tensile strain (%)			
	Max. strain 1 cycle (500 N)	Min. Strain 1 cycle (100 N)	Max. strain 10 cycles (500 N)	Min. strain 10 cycles (load 1N)
Amino Resin Samples	1.1	0.29	1.32	0.16
Phenolic Resin Samples	1.36	0.42	1.55	0.24
% difference	19.1% decrease	30.9 % decrease	14.8% decrease	33.3% decrease
ratio	0.81	0.69	0.85	0.67

Example 6 - Edge waviness test:

A comparative phenolic resin treated polyester fabric sample and an inventive amino resin treated polyester fabric sample were prepared as described above in Examples 4 and 5.

The edge waviness of the samples was examined. The edge of the inventive amino resin treated fabric is shown in FIG. 8. The edge of the comparative phenolic resin treated fabric is shown in FIG. 9. The maximum edge waviness (i.e., the maximum deviation inward or outward from a straight edge) of the treated fabric specimens was measured.

The amino resin treated fabric had no visible edge waviness. In contrast, the phenolic resin treated fabric had an edge waviness of 10 mm. The reduced edge waviness of the amino resin treated fabric is beneficial because it provides a flatter and more uniform surface for the application of an abrasive layer, which in turn reduces waste and processing costs associated with making a coated abrasive article with the amino resin treated fabric, and is also expected to maintain or enhance the abrasive performance.

Example 7 - Tensile strength and elongation rate testing

An amino resin treated fabric is prepared similarly as described in Example 4, except that 72 parts by weight of ATMM amino resin was mixed with 1 part by weight of catalyst and 26 parts by weight of water to make the amino resin solution. Polyester blend (90 wt% polyester, 10 wt% cotton) fabric (gage length 20 cm, width 5 cm) was submerged in the amino resin solution and pressed to squeeze out excess solution. The weight of the add-on resin was 110 to 115 grams per square meter (gsm) of the fabric. The saturated fabric was then heated in an oven at about 105 °C for 17 hours to completely cure the amino resin. The tensile strength and elongation rate at 600 N was tested at 200 mm/min. Comparative results of the amino treated polyester fabric versus an untreated polyester fabric are listed in table 6, below.

Table 6 - Tensile strength and elongation rate of treated and untreated fabric

	Treated		Untreated	
	warp	weft	warp	weft
Tensile strength (N)	2935.4	1849	2232.5	1693
Elongation rate (%)	4.9	4.4	10	7.7

The data shows that the amino resin treated fabric had a significantly greater tensile strength in both the warp direction ($((2935.4-2232.5)/2232.5)*100 = 31.5\%$ increase) and weft direction ($((1849-1693)/1693)*100 = 9.2\%$ increase). Additionally, the elongation rate of the amino resin treated fabric was significantly lower than the untreated fabric in both the warp direction ($((4.9-10)/10)*100 = 51\%$ decrease) and the weft direction ($((4.4-7.7)/7.7)*100 = 42.8\%$ decrease).

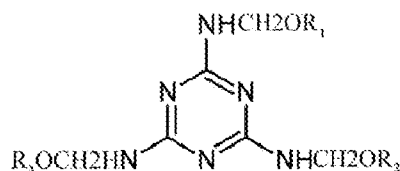
In the foregoing, reference to specific embodiments and the connections of certain components is illustrative. It will be appreciated that reference to components as being coupled or connected is intended to disclose either direct connection between said components or indirect connection through one or more intervening components as will be appreciated to carry out the methods as discussed herein. As such, the above-disclosed subject matter is to be considered illustrative, and not restrictive, and the appended claims are intended to cover all such modifications, enhancements, and other embodiments, which fall within the true scope of the present invention. Moreover, not all of the activities described above in the general description or the examples are required, that a portion of a specific activity can not be required, and that one or more further activities can be performed in addition to those described. Still further, the order in which activities are listed is not necessarily the order in which they are performed.

The disclosure is submitted with the understanding that it will not be used to limit the scope or meaning of the claims. In addition, in the foregoing disclosure, certain features that are, for clarity, described herein in the context of separate embodiments, can also be provided in combination in a single embodiment. Conversely, various features that are, for brevity, described in the context of a single embodiment, can also be provided separately or in any subcombination. Still, inventive subject matter can be directed to less than all features of any of the disclosed embodiments.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any feature(s) that can cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature of any or all the claims.

5 Thus, to the maximum extent allowed by law, the scope of the present invention is to be determined by the broadest permissible interpretation of the following claims and their equivalents, and shall not be restricted or limited by the foregoing detailed description.

Item. 1. An amino resin treated backing material comprising:
an amino resin comprising a modified melamine formaldehyde resin having a formula



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wherein R₁, R₂, R₃ each represents an independent substituent selected from hydrogen and alkyl groups having one to four carbon atoms; and
a backing material, wherein said backing material is impregnated with said amino resin.

Item 2. An amino resin treated backing material comprising:
15 an amino resin comprising an alkylated trimethylol melamine obtained by reaction of trimethylol melamine with alkanol; and
a backing material, wherein said backing material is impregnated with said amino resin.

Item 3. The amino resin treated backing material according to item 2, wherein the alkanol has 1 to 4 carbon atoms.

20 Item 4. The amino resin treated backing material according to item 3, wherein the alkanol is methanol.

Item 5. The amino resin treated backing material according to item 1 or 2, wherein the backing material comprises a polyester fabric.

25 Item 6. The amino resin treated backing material according to item 5, wherein the backing material further comprises cotton, viscose, polyamine, or combinations thereof.

Item 7. The amino resin treated backing material according to item 5, wherein the polyester fabric comprises at least about 50 wt% polyester.

Item 8. The amino resin treated backing material according to item 1 or 2, wherein the amount of impregnation is equal to an add-on weight of amino resin solution in a range from 10 g/m²
30 to 300 g/m² of backing material.

Item 9. The amino resin treated backing material according to item 8, wherein the add-on amino resin solution is cured at a temperature of at least 95 °C.

Item 10. The amino resin treated backing material according to item 9, wherein the add-on amino resin solution is cured at a temperature of not greater than 175°C.

Item 11. The amino resin treated backing material according to item 9, wherein the add-on amino resin solution is at least partially cured.

5 Item 12. The amino resin treated backing material according to item 11, wherein the backing material is tack free.

Item 13. The amino resin treated backing material according to item 12, wherein the tack free cure time is within a range of 30 to 300 seconds.

10 Item 14. The amino resin treated backing material according to item 11, wherein the tensile strength factor is within a range of 1.0 to 2.5.

Item 15. The amino resin treated backing material according to item 11, having an elongation rate factor within a range of not less than 0.3 to not greater than 1.0.

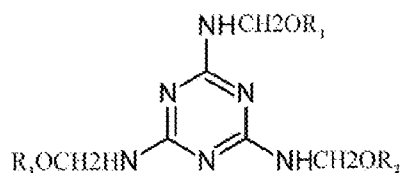
Item 16. The amino resin treated backing material according to item 12, wherein the amino resin treated backing material is free of bubbles.

15 Item 17. The amino resin treated backing material according to item 11, having a body retention factor within a range of in a range of not less than about 0.4 to not greater than about 1.0.

Item 18. The amino resin treated backing material according to item 11, wherein the amino resin treated backing material has an edge waviness of 3mm or less.

20 Item 19. A coated abrasive article comprising:
an amino resin treated backing material according to item 1 or 2, and
an abrasive layer disposed on the amino resin treated backing material.

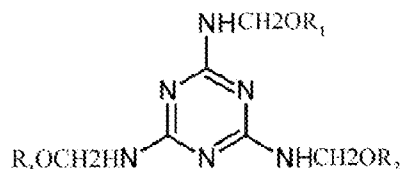
Item 20. A coated abrasive article comprising:
an amino resin treated backing material impregnated with a cured modified melamine formaldehyde resin having the formula:



25 wherein R₁, R₂, R₃ each represents an independent substituent selected from hydrogen and alkyl groups having one to four carbon atoms; and
an abrasive layer disposed on the amino resin treated backing material.

30 Item 21. A process of making an amino resin treated backing material comprising:
mixing water, catalyst, and a modified melamine formaldehyde resin to form an amino resin solution,
saturating a backing material with said amino resin solution to form a saturated backing material; and

curing said saturated backing material to form the amino resin treated backing material, wherein the modified melamine formaldehyde resin has the formula



wherein R1, R2, R3 each represents an independent substituent selected from a hydrogen or an alkyl group having one to four carbon atoms.

Item 22. The process according to item 21, further comprising adjusting the amount of saturation of the backing material prior to curing the saturated backing material.

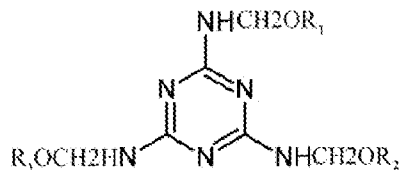
Item 23. The process according to item 21, wherein the saturated backing material is cured at a temperature in a range of 100 °C to 150 °C.

Item 24. The process according to item 23, wherein the catalyst is selected from the group consisting of phosphoric acid, alkyl acid phosphates, amine blocked alkyl benzene sulfonic acid, hydrochloric acid, naphthalene sulfonic acid, alkyl phenyl phosphate, alkyl benzene sulfonic acid, blocked para toluene sulfonic acid(p-TSA), combinations thereof.

Item 25. The process according to item 21, wherein the weight ratio of catalyst to amino resin is within a range from 1:800 to 1:16.

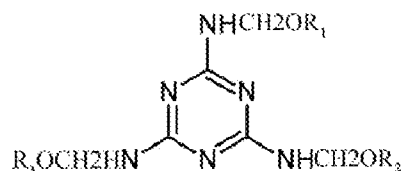
WHAT IS CLAIMED IS:

1. An amino resin treated backing material comprising:
an amino resin comprising a modified melamine formaldehyde resin having a formula



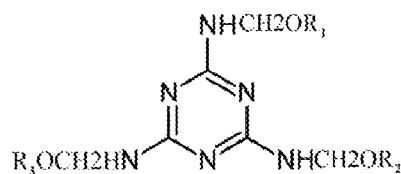
- wherein R1, R2, R3 each represents an independent substituent selected from hydrogen and alkyl groups having one to four carbon atoms; and
a backing material, wherein said backing material is impregnated with said amino resin.
2. An amino resin treated backing material comprising:
an amino resin comprising an alkylated trimethylol melamine obtained by reaction of trimethylol melamine with alkanol; and
a backing material, wherein said backing material is impregnated with said amino resin.
 3. The amino resin treated backing material according to claim 2, wherein the alkanol has 1 to 4 carbon atoms.
 4. The amino resin treated backing material according to claim 3, wherein the alkanol is methanol.
 5. The amino resin treated backing material according to claim 2, wherein the backing material comprises a polyester fabric.
 6. The amino resin treated backing material according to claim 2, wherein the amount of impregnation is equal to an add-on weight of amino resin solution in a range from 10 g/m² to 300 g/m² of backing material.
 7. The amino resin treated backing material according to claim 2, wherein the add-on amino resin solution is cured at a temperature of not greater than 175°C.
 8. The amino resin treated backing material according to claim 9, wherein the add-on amino resin solution is at least partially cured.
 9. The amino resin treated backing material according to claim 8, wherein the backing material is tack free.
 10. The amino resin treated backing material according to claim 9, wherein the tack free cure time is within a range of 30 to 300 seconds.
 11. The amino resin treated backing material according to claim 8, wherein the tensile strength factor is within a range of 1.0 to 2.5.

12. The amino resin treated backing material according to claim 8, having an elongation rate factor within a range of not less than 0.3 to not greater than 1.0.
13. The amino resin treated backing material according to claim 8, having a body retention factor within a range of in a range of not less than about 0.4 to not greater than about 1.0.
14. A coated abrasive article comprising:
an amino resin treated backing material impregnated with a cured modified melamine formaldehyde resin having the formula:



wherein R1, R2, R3 each represents an independent substituent selected from hydrogen and alkyl groups having one to four carbon atoms; and
an abrasive layer disposed on the amino resin treated backing material.

15. A process of making an amino resin treated backing material comprising:
mixing water, catalyst, and a modified melamine formaldehyde resin to form an amino resin solution,
saturating a backing material with said amino resin solution to form a saturated backing material;
and
curing said saturated backing material to form the amino resin treated backing material,
wherein the modified melamine formaldehyde resin has the formula



wherein R1, R2, R3 each represents an independent substituent selected from a hydrogen or an alkyl group having one to four carbon atoms.

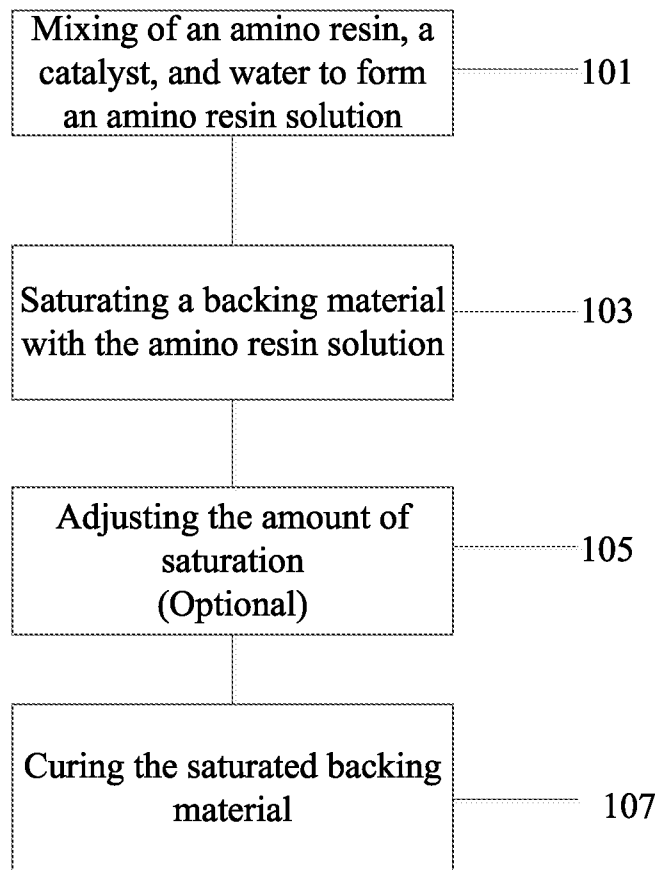


FIG. 1

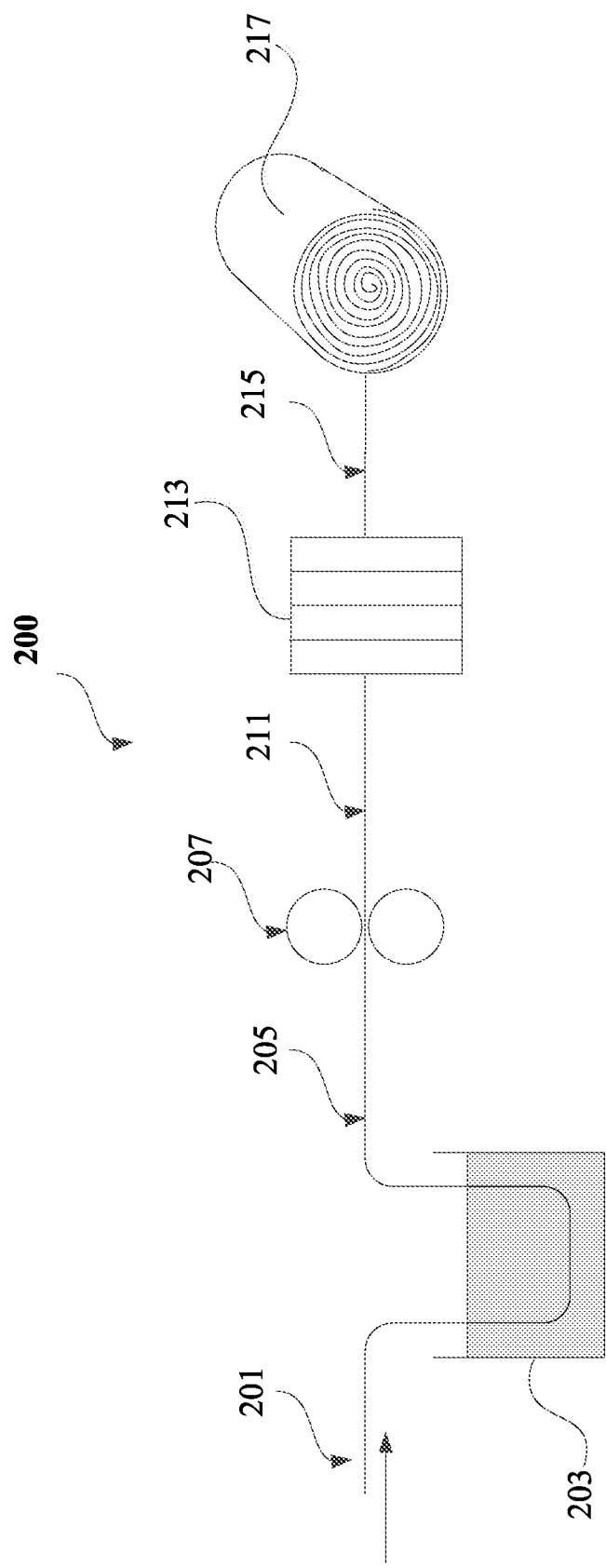


FIG. 2

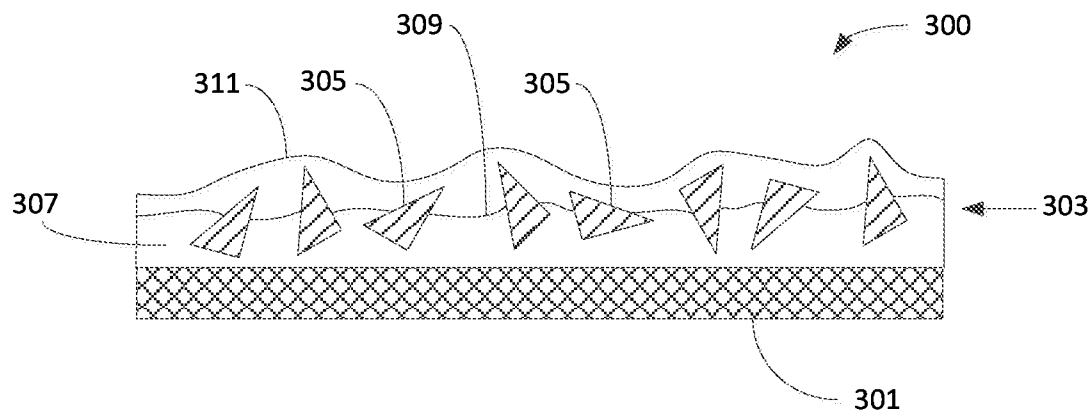


FIG. 3

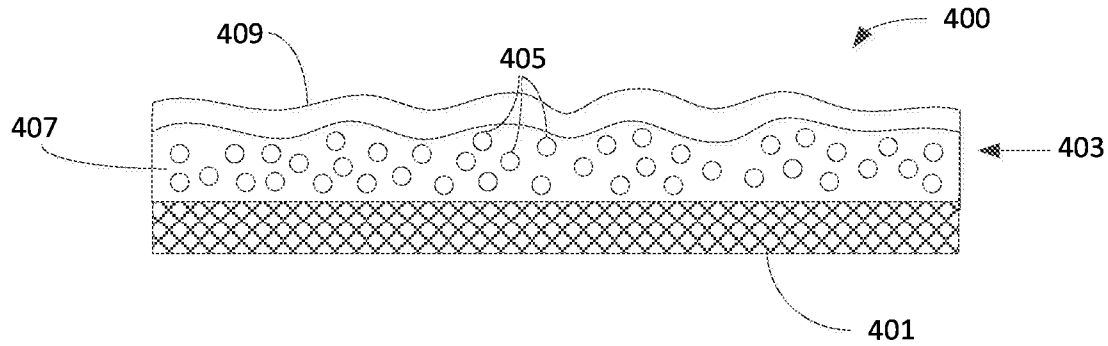


FIG. 4

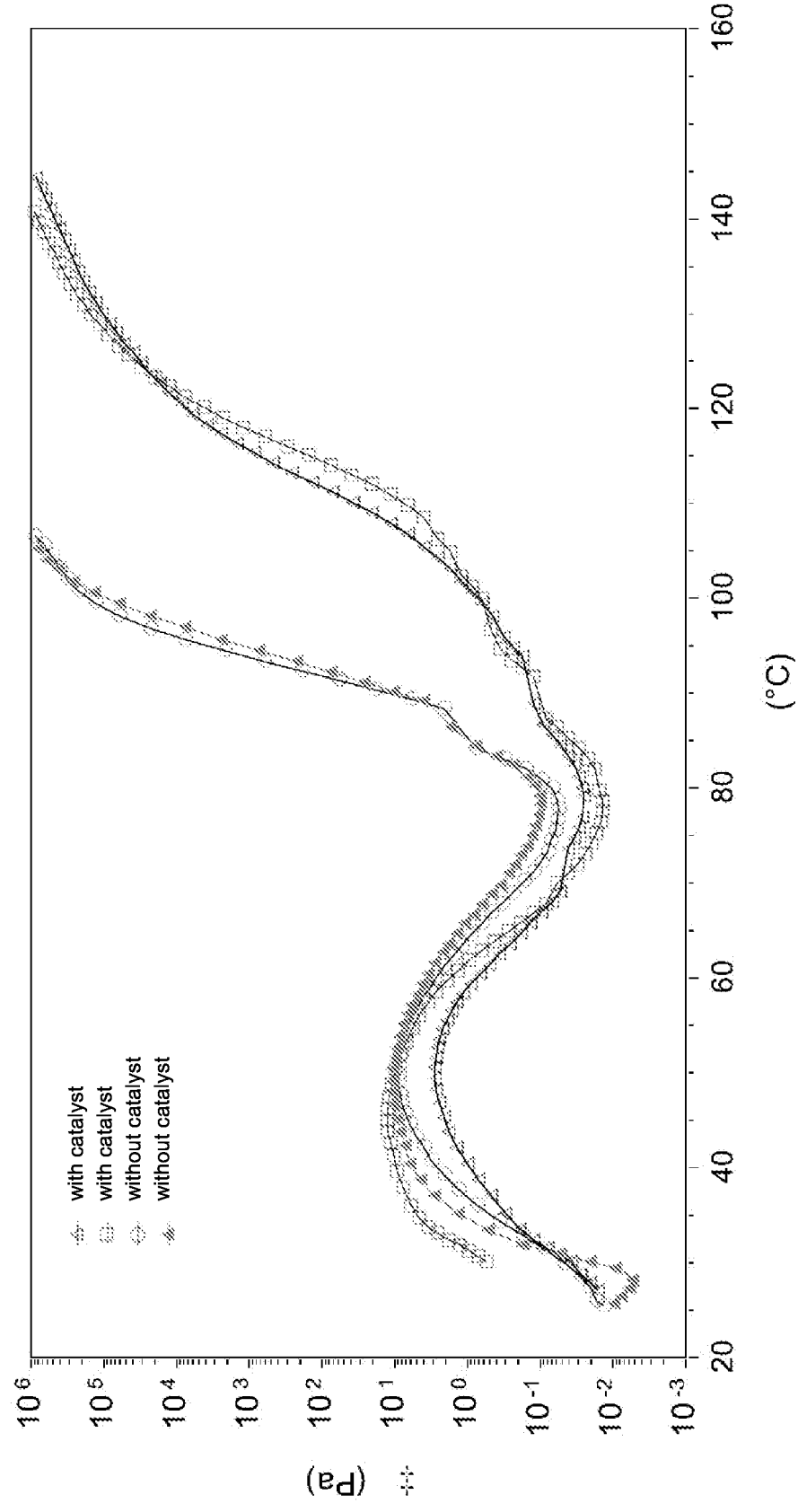


FIG. 5

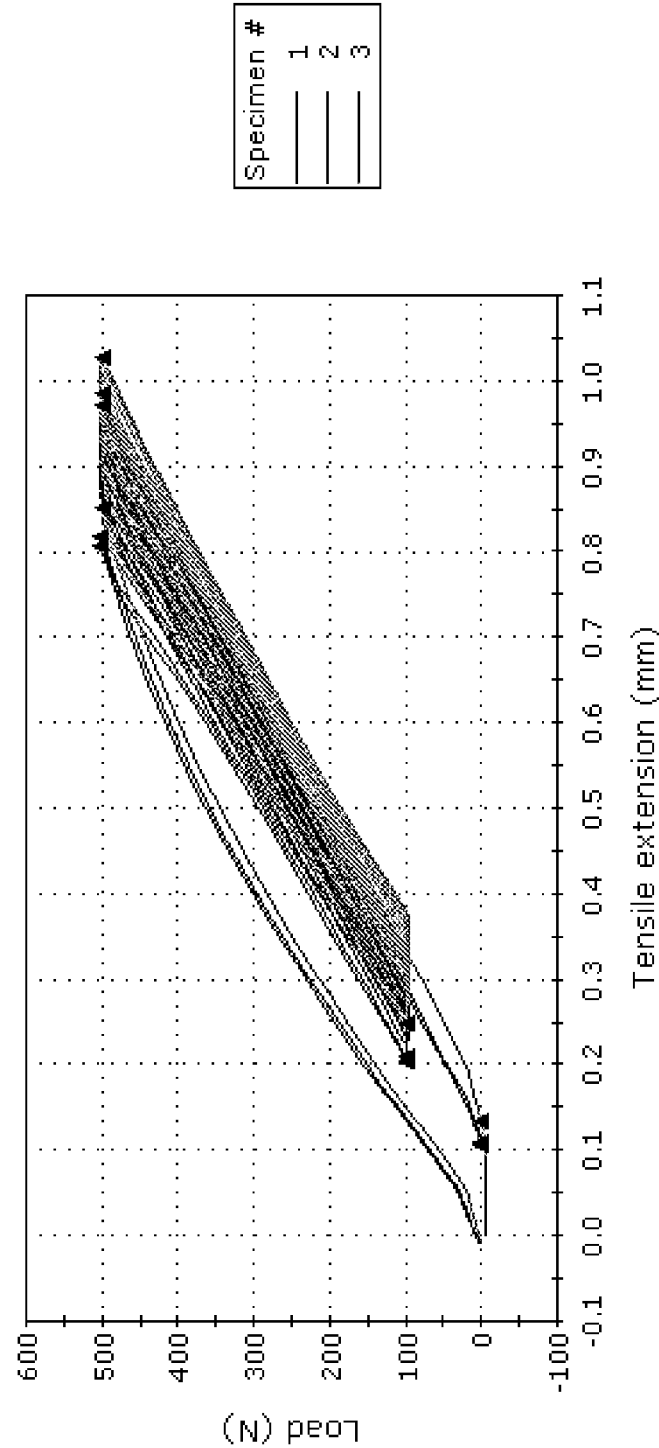
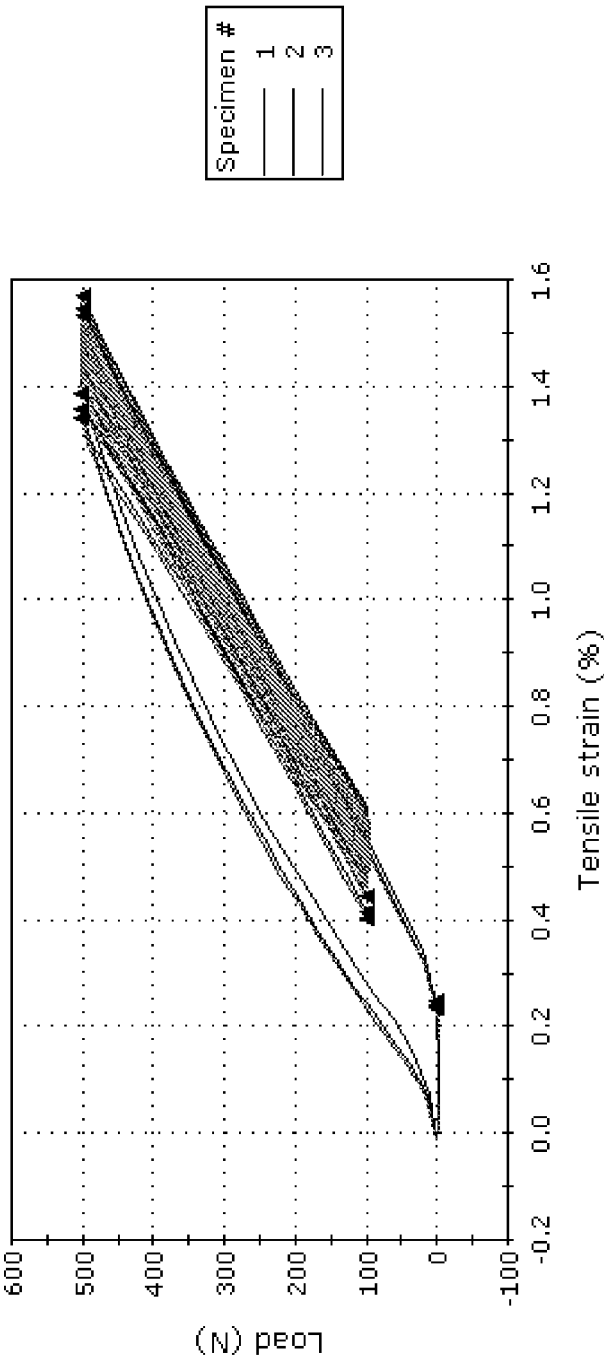


FIG. 6



Specimen #
1
2
3

FIG. 7



FIG. 8

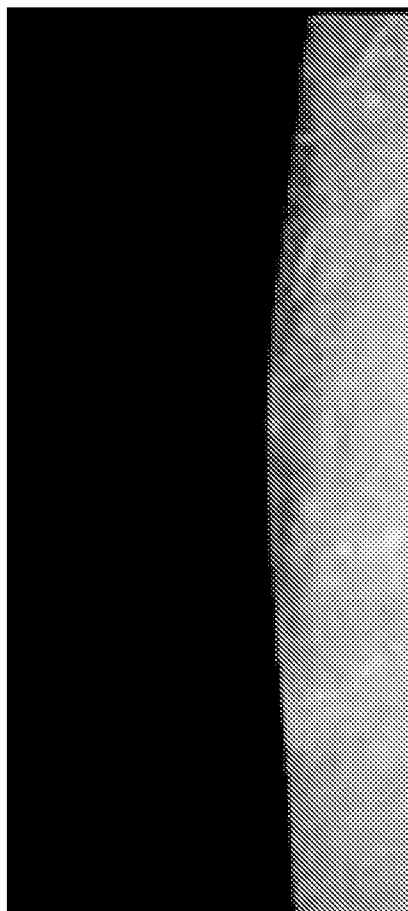


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/060945**A. CLASSIFICATION OF SUBJECT MATTER****C08G 12/32(2006.01)i, C08G 14/12(2006.01)i, C08K 5/3477(2006.01)i, C08J 7/04(2006.01)i, C08J 5/04(2006.01)i, B24D 3/28(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C08G 12/32; H01B 1/06; B32B 27/42; B32B 23/08; E02D 27/00; B05D 1/36; C09D 161/06; B24D 3/24; B05D 1/18; C08G 14/12; C08K 5/3477; C08J 7/04; C08J 5/04; B24D 3/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: amino resin, modified melamine formaldehyde resin, backing material, abrasive article, alkylated trimethylol melamine resin

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013-0111822 A1 (OMBE WANDJI, NADEGE et al.) 09 May 2013 See abstract; paragraphs [0001], [0040], [0045], [0051]-[0072] and [0080]-[0084]; and claims 1 and 19.	1-15
A	US 5562745 A (GAGLIARDI, JOHN J. et al.) 08 October 1996 See abstract; columns 4-6 and 13-16; and claims 1 and 14.	1-15
A	US 5061294 A (HARMER, WALTER L. et al.) 29 October 1991 See abstract; columns 2 and 3; and claims 1 and 9.	1-15
A	US 4713299 A (TAYLOR, ARTHUR R. et al.) 15 December 1987 See abstract; columns 2-4; and claim 1.	1-15
A	US 5558906 A (ALBRINCK, DONALD J. et al.) 24 September 1996 See abstract; columns 3 and 4; and claim 1.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

16 January 2015 (16.01.2015)

Date of mailing of the international search report

19 January 2015 (19.01.2015)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/060945

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