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## (54) Title: COMPOSITIONS COMPRISING STYLING POLYMER

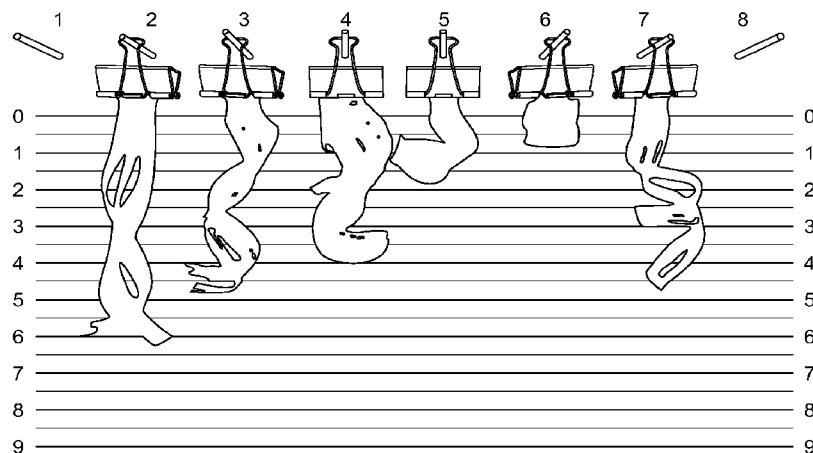


Figure 1

(57) Abstract: A hair styling polymer derived from polymerizing (a) at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) at least one functionalized or unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and (d) optionally at least one crosslinking agent. Also described is a process of preparing said styling polymer, hair styling compositions, and method of use.

## COMPOSITIONS COMPRISING STYLING POLYMER

### FIELD OF THE INVENTION

[0001] The present application relates to hair styling polymers, and more particularly, to compositions comprising copolymers of *n*-hydroxyalkylated lactams and their application in hair styling, a process for preparing the same and method of use thereof.

### BACKGROUND OF THE INVENTION

[0002] Many people express interest in hair styling benefits like shine, softness, manageability, especially for wavy, curly, or frizzy hair. Typically, these benefits are attained using hair care products like rinse-off shampoos and conditioners, and leave-in products that are not washed off like gels and mousses. Likewise, people with straight hair often curl their hair to change their hair style and appearance. Curling irons and hair curlers can provide curls and/or waves, which are then held in place using hair spray. In both scenarios, however, the results are often short-lived as the hair styling benefits are not durable, but rather are lost after washing. Other styling products, like permanent wave and high-pH hair straightening formulas, achieve a permanent hair style by altering the chemical nature of the internal hair structure. Due to the chemical processes involved, these “permanent” products may achieve long-enduring style at the cost of considerable damage to the hair. Additionally, consumers may find the results last too long, and therefore do not enjoy the option of being able to undo the style without cutting off the hair or risking further chemical modification of the hair. Hence, there is a need for hair styling products that provide durable, but not permanent benefits without being harsh or damaging to hair.

[0003] US Publication Number 20100166985 discloses aqueous dispersions of (meth)acrylic esters of polymers comprising N-hydroxyalkylated lactam units, to processes for preparing them, and to the use of (meth)acrylic esters of polymers comprising N-hydroxyalkylated lactam units for treating paper.

[0004] DE2048312 assigned to BASF AG discloses polymers containing lactam groups used for production of molded bodies, coatings and adhesives.

[0005] US Publication Numbers 20050101740 and 20050238594 disclose block ethylenic copolymers comprising a vinyl lactam block for a cosmetic or pharmaceutical composition, such as a hair composition.

[0006] In view of the foregoing, there is an increasing demand for hair care products designed to retain the properties of “*virgin hair*” and to prevent possible damage during the chemical and mechanical treatment.

[0007] Accordingly, the primary objective of the present application is to provide a hair styling polymer derived from polymerizing: (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one functionalized or unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to 10% by weight of at least one crosslinking agent.

[0008] Yet another objective of the the present application is to provide a hair styling composition comprising, (i) a hair styling polymer derived from polymerizing: (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one functionalized/unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to 10% by weight of at least one crosslinking agent; and (ii) one or more cosmetically acceptable additives.

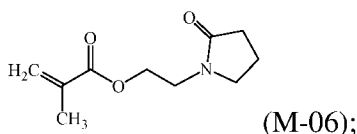
## SUMMARY OF THE INVENTION

[0009] The primary aspect of the present application relates to a hair styling polymer derived from polymerizing: (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one functionalized or unfunctionalized olefinically-

unsaturated acid monomer or a salt thereof; and (d) 0 to 10% by weight of at least one crosslinking agent.

**[0010]** Another aspect of the present application relates to a hair styling polymer derived from polymerizing: (a) about 0.1 to 50% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 5 to 80% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk) acrylates; (c) about 1 to 50% by weight of at least one functionalized/ unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; (d) 0 to 5% by weight of at least one crosslinking agent.

**[0011]** According to one important aspect of the present application, there is provided a hair styling polymer derived from polymerizing: (a) about 0.1 to 50% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety has a structure of:



(b) about 10 to 75% by weight of methyl acrylate and butyl acrylate; (c) about 1 to 50% by weight of methacrylic acid; and (d) 0 to 5% by weight of pentaerythritol triallyl ether (PETE).

**[0012]** In accordance with certain important embodiments, the present application relates to a hair styling composition comprising: (i) a hair styling polymer derived from polymerizing: (a) about 0.1 to 99.9% by weight of at least one at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one functionalized/ unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to about 10% by weight of at least one crosslinking agent; and (ii) one or more cosmetically acceptable additives.

**[0013]** In accordance with certain embodiments, the present application relates to treating or fixing regular or damaged hair substrate comprising contacting said hair substrate with an effective amount of hair styling composition comprising (i) a hair styling polymer of (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to about 10% by weight of at least one crosslinking agent; and (ii) one or more of cosmetically acceptable additives.

**[0014]** In yet another aspect of the present application, there is provided a process for preparing a hair styling polymer comprising polymerizing (a) about 0.1 to 99.9% by weight of at least one monomer comprising or derived from at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one functionalized/ unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to about 10% by weight of at least one crosslinking agent.

### BRIEF DESCRIPTION OF THE FIGURES

[0015] Further embodiments of the present application can be understood with the appended figure.

[0016] **Figure 1:** Shows a comparative graphical presentation of HHCR (@ 12 hrs) with or without M-06 containing polymers, and wherein Label **2** is 2% PVP, Label **3** is Commercial Syoss Extra Hold, Label **4** is 2% HEC:Acrylate 30:70 (1600-595), Label **5** is 2% acrylate/M-06 (100/0) + Styleeze W-10, Label **6** is 2 % acrylate/M-06 (85/15) and Label **7** is 2% acrylate/M-06 (100/0).

## DETAILED DESCRIPTION OF THE INVENTION

[0017] While this specification concludes with claims particularly pointing out and distinctly claiming that which is regarded as the invention, it is anticipated that the invention can be more readily understood through reading the following detailed description of the invention and study of the included examples.

[0018] As used herein, the words “comprising” (and any form of comprising, such as “comprise” and “comprises”), “having” (and any form of having, such as “have” and “has”), “including” (and any form of including, such as “includes” and “include”) or “containing” (and any form of containing, such as “contains” and “contain”) are inclusive or open-ended and do not exclude additional, unrecited elements or method steps. The term “or combinations thereof” as used herein refers to all permutations and combinations of the listed items preceding the term.

[0019] All percentages, parts, proportions and ratios as used herein, are by weight of the total composition, unless otherwise specified. All such weights as they pertain to listed ingredients are based on the active level and, therefore, do not include solvents or by-products that may be included in commercially available materials, unless otherwise specified.

[0020] All references to singular characteristics or limitations of the present application shall include the corresponding plural characteristic or limitation, and *vice-versa*, unless otherwise specified or clearly implied to the contrary by the context in which the reference is made.

[0021] Numerical ranges as used herein are intended to include every number and subset of numbers contained within that range, whether specifically disclosed or not. Further, these numerical ranges should be construed as providing support for a claim directed to any number or subset of numbers in that range.

[0022] As used herein, the words “preferred,” “preferably” and variants thereof refer to embodiments of the invention that afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not

imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the invention.

**[0023]** References herein to "one embodiment," or "one aspect" or "one version" or "one objective" of the invention may include one or more of such embodiment, aspect, version or objective, unless the context clearly dictates otherwise.

**[0024]** All publications, articles, papers, patents, patent publications, and other references cited herein are hereby incorporated herein by reference for all purposes to the extent consistent with the disclosure herein.

**[0025]** The term "polymer" refers to a compound comprising repeating structural units (monomers) connected by covalent chemical bonds. The definition includes oligomers. Polymers may be further derivatized (example by hydrolysis), crosslinked, grafted or end-capped. Non-limiting examples of polymers include copolymers, terpolymers, quaternary polymers, and homologues. A polymer may be a random, or an alternating polymer, or a polymer with a mixed random and/or alternating structure. Polymers may further be associated with solvent adducts.

**[0026]** The term "homopolymer" refers to a polymer that consists essentially of a single monomer type. The term "non-homopolymer" refers to a polymer that comprises more than one monomer types. The term "copolymer" refers to a non-homopolymer that comprises two different monomer types. The term "terpolymer" refers to a non-homopolymer that comprises three different monomer types. The term "branched" refers to any non-linear molecular structure. The term includes both branched and hyper-branched structures

**[0027]** The term "free radical addition polymerization initiator" refers to a compound used in a catalytic amount to initiate a free radical addition polymerization. The choice of an initiator depends mainly on its solubility and decomposition temperature.

**[0028]** "Polymerize" and "cure" are interchangeable and mean to polymerize the coating composition. The polymerization or curation may alter the physical state of the composition, to make it transform from a fluid to a less fluid state, to go from a tacky or non-tacky state, to go from a soluble to insoluble state, or to decrease the amount of polymerizable monomer by its consumption in a reaction.

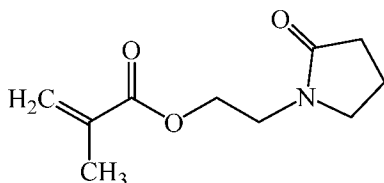
[0029] The term "crosslinked" herein refers to a composition containing intramolecular and/or intermolecular crosslinks, whether arising through covalent or non-covalent bonding. "Noncovalent" bonding includes both hydrogen bonding and electrostatic (ionic) bonding.

[0030] The use of the term "at least one" will be understood to include one as well as any quantity more than one, including but not limited to, 1, 2, 3, 4, 5, 10, 15, 20, 30, 40, 50, 100, etc. The term "at least one" may extend up to 100 or 1000 or more depending on the term to which it is attached. In addition, the quantities of 100/1000 are not to be considered limiting as lower or higher limits may also produce satisfactory results.

[0031] The terms "personal care composition" and "cosmetics" refer to compositions intended for use on or in the human body, such as skin, sun, hair, oral, cosmetic, and preservative compositions, including those to alter the color and appearance of the skin and hair.

[0032] The phrase "pharmaceutically acceptable" or "cosmetically acceptable" refers to molecular entities and compositions that are generally regarded as safe. Particularly, as used herein, the term "pharmaceutically acceptable" or "cosmetically acceptable" means approved by a regulatory agency of the appropriate governmental agency or listed in the U.S. Pharmacopoeia or other generally recognized pharmacopoeia to be useful for animals, and more particularly for human beings.

[0033] The term "M-06" refers to "N-(2-hydroxyethyl)pyrrolidone methacrylate" or "hydroxyethylpyrrolidone methacrylate" and these terms are synonymously used in this application, the structure of M-06 (CAS NO: 946-25-8) is provided below:

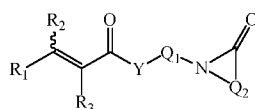


[0034] The term "keratinous substrate" or "hair substrate" refers to human keratinous surface, and may be chosen from, for example, hair, eyelashes, and eyebrows, as well as the skin and nails. Other mammals are also envisioned.

**[0035]** The term “viscosity” refers to the proportionality coefficient between shear stress and shear rate, and describes a composition's resistance to flow. Because viscosity is dependent on shear rate, specific measurement information (such as viscometer, flow apparatus/spindle, and shear rate) is required to properly define viscosity. As used herein, viscosity refers to the proportionality coefficient determined from low shear rate, rotational flow, especially the viscosity measured by the Brookfield LVT and Brookfield RVT viscometers typically operating at 10 revolutions per minute (*rpm*) at 25°C. References describing the Brookfield measurement of viscosities include the following, each of which is hereby incorporated in its entirety by reference: Thibodeau, L., "Measuring viscosity of pastes," American Laboratory News, June 2004; McGregor, R.G., "Shelf life: does viscosity matter?" Pharmaceutical Online, October 31, 2007; and McGregor, R.G., "When ointments disappoint, the viscosity story," Brookfield Engineering brochure.

**[0036]** The present application relates to a hair styling polymer derived from polymerizing: (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one functionalized or unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to about 5 % by weight of at least one crosslinking agent.

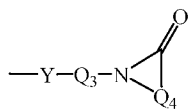
**[0037]** In particular embodiments, the monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety has the structure:



(1)

wherein each  $R_1$ ,  $R_2$  and  $R_3$  is independently selected from the group consisting of

hydrogen, halogens, functionalized and unfunctionalized  $C_1$ - $C_4$  alkyl, and  $\text{—}\overset{\text{O}}{\parallel}{\text{C}}\text{—X}$ ; each X is independently selected from the group consisting of  $\text{OR}_4$ , OM, halogen,  $\text{N(R}_5\text{)(R}_6\text{)}$ ,



, and combinations thereof; each Y is independently oxygen, NR<sub>7</sub> or sulfur; each R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub> and R<sub>7</sub> is independently selected from the group consisting of hydrogen and functionalized and unfunctionalized alkyl; each M is independently selected from the group consisting of metal ions, ammonium ions, organic ammonium cations, and combinations thereof; and each Q<sub>1</sub>, Q<sub>2</sub>, Q<sub>3</sub>, and Q<sub>4</sub> is independently selected from the group consisting of functionalized and unfunctionalized alkylene.

**[0038]** Particularly, each Q<sub>1</sub>, Q<sub>2</sub>, Q<sub>3</sub>, and Q<sub>4</sub> is independently selected from the group consisting of functionalized and unfunctionalized C<sub>1</sub> – C<sub>12</sub> alkylene.

**[0039]** In one non-limiting embodiment, each R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> is independently selected from the group consisting of hydrogen, methyl and combinations thereof. Particularly, R<sub>1</sub> and R<sub>2</sub> are hydrogen and R<sub>3</sub> is hydrogen or methyl.

**[0040]** In another non-limiting embodiment, each R<sub>1</sub> and R<sub>3</sub> is independently hydrogen

or methyl; R<sub>2</sub> is  $\text{—}\overset{\text{O}}{\parallel}\text{C—X}$ ; X is selected from the group consisting of OR<sub>4</sub>, OM, halogens, and N(R<sub>5</sub>)(R<sub>6</sub>); each R<sub>4</sub>, R<sub>5</sub>, and R<sub>6</sub> is independently selected from the group consisting of hydrogen and functionalized and unfunctionalized alkyl; and each M is independently selected from the group consisting of metal ions, ammonium ions, organic ammonium

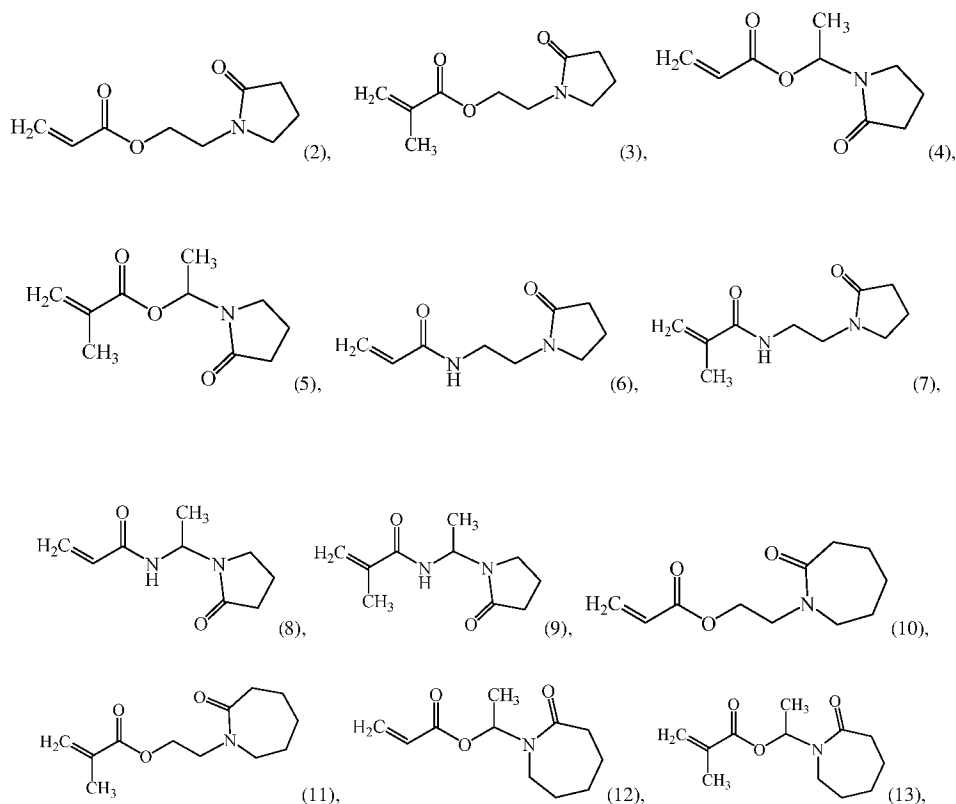
cations, and combinations thereof. Particularly, R<sub>1</sub> and R<sub>3</sub> are hydrogen and R<sub>2</sub> is  $\text{—}\overset{\text{O}}{\parallel}\text{C—X}$ ; X is selected from the group consisting of OR<sub>4</sub>, OM and N(R<sub>5</sub>)(R<sub>6</sub>); each R<sub>4</sub>, R<sub>5</sub>, and R<sub>6</sub> is independently selected from the group consisting of hydrogen and functionalized and unfunctionalized C<sub>1</sub>-C<sub>4</sub> alkyl; and each M is independently selected from the group consisting of metal ions, ammonium ions, organic ammonium cations, and combinations thereof.

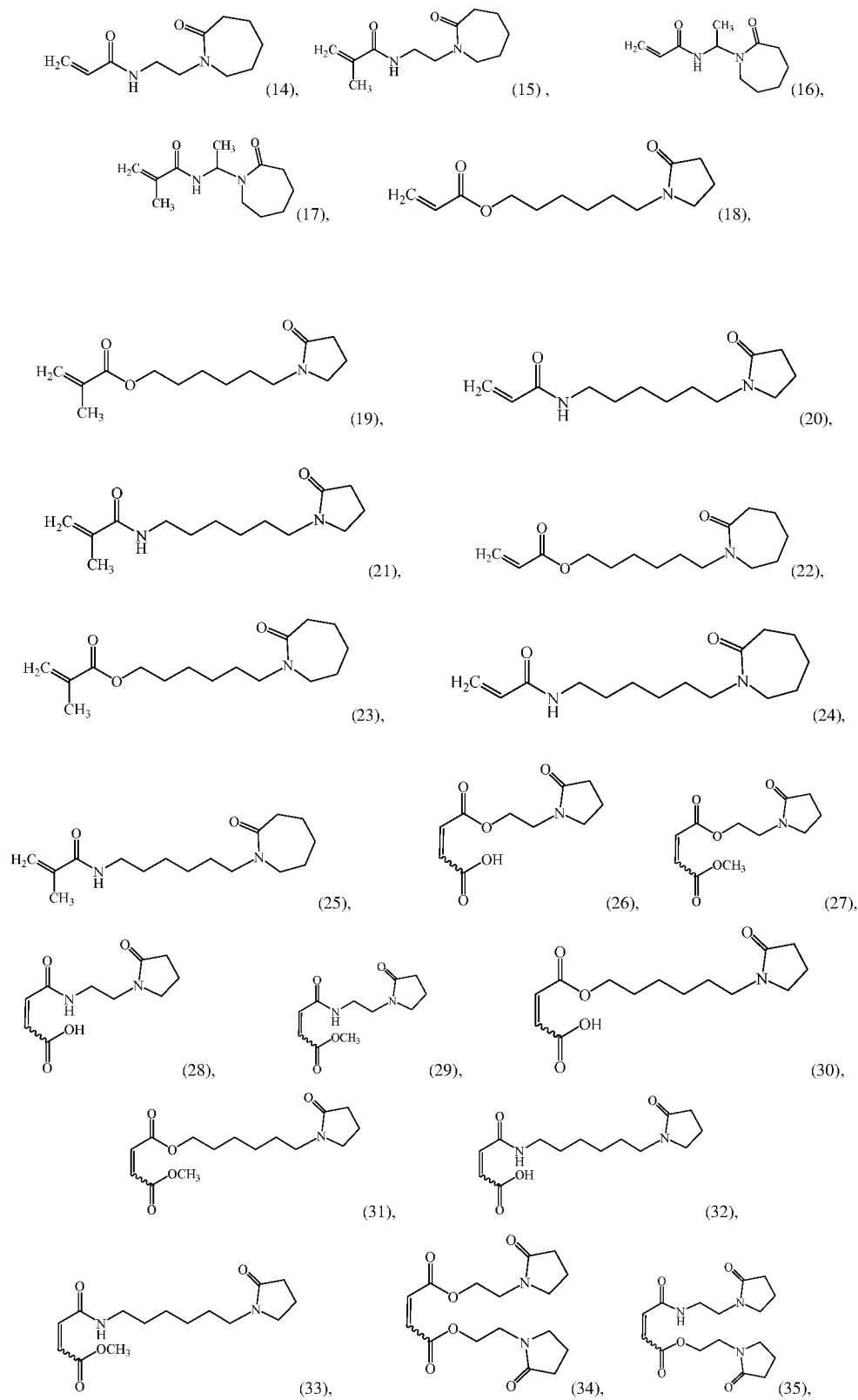
**[0041]** The first polymerizable unit, defined by structure (1), can be synthesized using the methods known in the art, e.g., by reaction of an N-hydroxylalkyl lactam with an acrylate, (meth)acrylate, anhydride, or similar compounds. Production methods are described in: U.S. Patent Nos. 2,882,262; 5,523,340; 6,369,163; U.S. Patent Application Publication 2007/123673; GB 924,623; 930,668; and 1,404,989; WO 03/006569; and EP

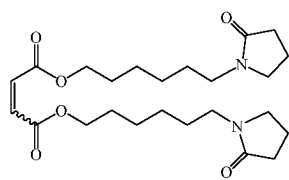
385918. Each of the previous disclosures is hereby incorporated herein by reference in its entirety.

**[0042]** The lactam-containing monomers shown in structures (2)-(57) can be obtained from condensation reactions that include an N-hydroxyalkyl lactam and an unsaturated carboxylic acid, an acrylate, a (meth)acrylate, or an anhydride. Suitable N-hydroxyalkyl lactams include N-hydroxymethyl pyrrolidone and caprolactam, N-hydroxyethyl pyrrolidone and caprolactam, and N-hydroxypropyl pyrrolidone and caprolactam. Non-limiting examples of carboxylic acids that can be used include: acrylic acid, methacrylic acid, itaconic acid, crotonic acid, fumaric acid, succinic acid, and maleic acid. Similarly, acrylates and (meth)acrylates include (without limitation) methyl, ethyl, butyl, octyl, ethyl hexyl acrylates and their (meth)acrylate analogues. Representative anhydrides include formic anhydride, succinic anhydride, maleic anhydride and acetic anhydride.

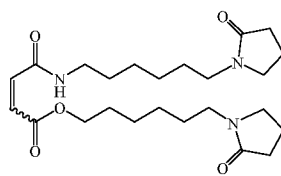
**[0043]** In particular embodiments, the monomer having at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety has a structure selected from the group consisting of:



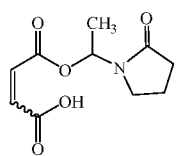




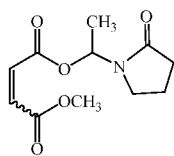
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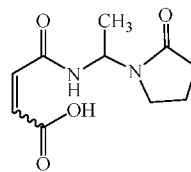
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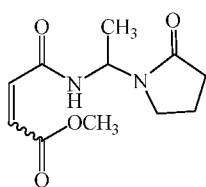
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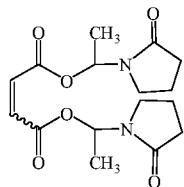
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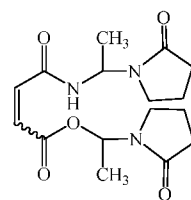
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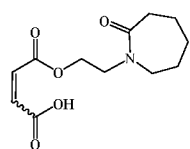
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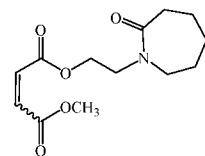
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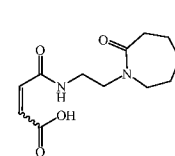
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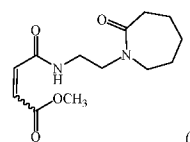
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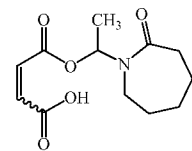
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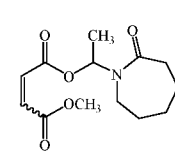
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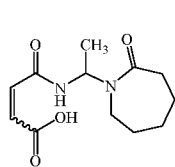
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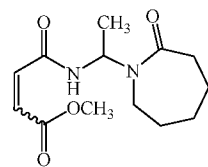
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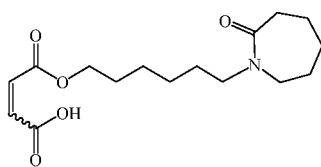
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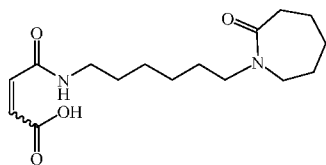
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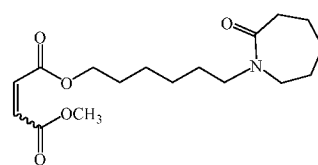
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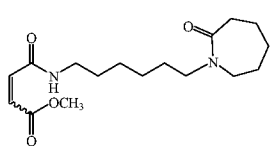
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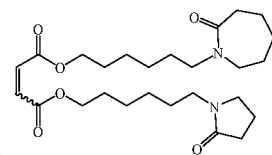
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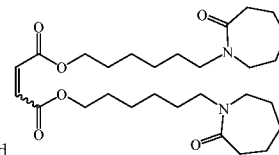
(54),



(55),



(56), and



(57).

[0044] Other suitable examples can be found in WO 2011/063208, the disclosure of which is hereby incorporated herein by reference in its entirety.

[0045] According to the current application, the monomer having at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety is present in an amount from about 0.1 % by weight to about 99.9 % by weight of the polymer. More particularly, the monomer having at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety can be present in an amount from about 0.1 % by weight to about 55 % by weight of the polymer. Even more particularly, the monomer having at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety can be present in an amount from about 0.1 % by weight to about 50 % by weight of the polymer.

[0046] In particular embodiments, functionalized or unfunctionalized alkyl (alk)acrylates group include (meth)acrylate, ethyl acrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate, butyl acrylate, *tert*-butyl acrylate, hexyl acrylate, 2-ethylhexyl acrylate, lauryl acrylate, ethylene glycol diacrylate, triethylene glycol diacrylate, tripropylene glycol diacrylate, 1,4-butanediol diacrylate and dimethacrylate, neopentyl glycol acrylate, neopentyl glycol methacrylate, 1,6-hexanediol diacrylate, 1,6-hexanediol dimethacrylate, 1,12-dodecanediol dimethacrylate, ethylene glycol dimethacrylate, diethylene glycol dimethacrylate, hexyl methacrylate, lauryl methacrylate, cyanoacrylate, polyethylene glycol diacrylate, polyethylene glycol dimethacrylate, polypropylene glycol diacrylate, polypropylene glycol dimethacrylate and combinations thereof.

[0047] The term "alkyl (alk) acrylate" refers to an alkyl ester of an acrylic acid or an alkyl acrylic acid.

[0048] In particular embodiments, functionalized and unfunctionalized alkyl (alk)acrylates comprise, 1,1,3,3-tetramethylbutyl acrylate, 1,1-dimethylhexyl acrylate, 6-methylheptyl acrylate, 7-methyloctyl acrylate, 2-propylheptyl acrylate, 8-methylnonyl acrylate, 9-methyldecyl acrylate, 10-methylundecyl acrylate, 11-methyldodecyl acrylate, 12-methyltridecyl acrylate, 13-methyltetradecyl acrylate, 14-methylpentadecyl acrylate, 15-methylhexadecyl acrylate, 16-methylheptadecyl acrylate, 17-methyloctadecyl acrylate, 2-ethylhexyl methacrylate, 1,1,3,3-tetramethylbutyl methacrylate, 1,1-dimethylhexyl

methacrylate, 6-methylheptyl methacrylate, 7-methyloctyl methacrylate, 2-propylheptyl methacrylate, 8-methylnonyl methacrylate, 9-methyldecyl methacrylate, 10-methylundecyl methacrylate, 11-methyldodecyl methacrylate, 12-methyltridecyl methacrylate, 13-methyltetradecyl methacrylate, 14-methylpentadecyl methacrylate, 15-methylhexadecyl methacrylate, 16-methylheptadecyl methacrylate, 17-methyloctadecyl methacrylate, and combinations thereof.

**[0049]** Particularly, the monomer having at least one functionalized and unfunctionalized alkyl (alk)acrylates is present in an amount from about 0.1 % by weight to about 99.9 % by weight of the polymer. Other non-limiting percentages include about 5 % by weight to about 85 % by weight of the polymer or from about 5 % by weight to about 80 % by weight of the polymer.

**[0050]** According to the current application, the functionalized or unfunctionalized olefinically-unsaturated acid monomer or a salt thereof can be selected from the group consisting of a functionalized/ unfunctionalized carboxylic acid-containing vinyl monomer, a functionalized/ unfunctionalized sulfonic acid-containing vinyl monomer, a functionalized/ unfunctionalized phosphonic acid-containing vinyl monomer and a combinations thereof.

**[0051]** Particularly, functionalized/ unfunctionalized carboxylic acid-containing vinyl monomers are polymerizable, ethylenically unsaturated monomers containing at least one carboxylic acid, sulfonic acid, or phosphonic acid group to provide an acidic or anionic functional site. These acid groups can be derived from monoacids or diacids, anhydrides of carboxylic acid, monoesters of diacids, and salts thereof.

**[0052]** Particularly, carboxylic acid containing monomers can be selected from the group consisting of acrylic acid, methacrylic acid, maleic acid, itaconic acid, N-(meth)acrylamidopropyl-N,N-dimethyl amino acetic acid, N-(meth)acryloyloxyethyl-N,N-dimethyl-amino acetic acid, N-(meth)acryloyloxyethyl,N,N-dimethyl-amino acetic acid, crotonic acid, (meth)acrylamidoglycolic acid, and 2-(meth)acrylamido-2-methylbutanoic acid.

**[0053]** Suitable acidic vinyl carboxylic acid-containing monomers include, but are not limited to acrylic acid, methacrylic acid, itaconic acid, citraconic acid, maleic acid, fumaric

acid, crotonic acid, aconitic acid, and the like. Anhydrides of dicarboxylic acids, such as maleic anhydride, itaconic anhydride, citraconic anhydride, and the like, can also be utilized as acidic vinyl monomers. Such anhydrides generally hydrolyze to the corresponding diacids upon prolonged exposure to water, or at elevated pH.

**[0054]** Suitable sulfonic acid group-containing monomers include, but are not limited to: vinyl sulfonic acid, 2-sulfoethyl methacrylate, styrene sulfonic acid, 2-acrylamido-2-methylpropane sulfonic acid (AMPS), allyloxybenzene sulfonic acid, and the like. More particularly, sodium salt of styrene sulfonic acid (SSSA) and AMPS can be employed.

**[0055]** Suitable phosphonic acid group-containing monomers include vinyl phosphonic acid, allyl phosphonic acid, 3-acrylamidopropyl phosphonic acid, and the like.

**[0056]** Particularly, the monomer having at least one functionalized/ unfunctionalized olefinically-unsaturated acid monomer or a salt is present in an amount from about 0.1 % by weight to about 99.9 % by weight of the polymer. Other non-limiting percentages would include 0.1 wt. % to about 55 wt. %, or about 0.1 % by weight to about 50 % by weight.

**[0057]** In a particular embodiment, the styling polymer of the current application further comprises repeating units derived from at least one crosslinker or crosslinking agent.

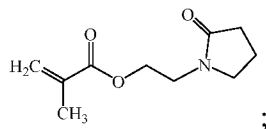
**[0058]** Non limiting examples of crosslinkers include: divinyl ethers of compounds selected from the group consisting of ethylene glycol, 1,3-propanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 1,7-heptanediol, 1,8-octanediol, 1,9-nonanediol, 1,10-decanediol, 1,11-unidecanediol, 1,12-dodecanediol, and combinations thereof; divinyl ethers of diethylene glycol, triethylene glycol, tetraethylene glycol, pentaethylene glycol, hexaethylene glycol, heptaethylene glycol, octaethylene glycol, nonaethylene glycol, decaethylene glycol, and polyalkylene glycols; methylenebis(meth)acrylamide; ethylene glycol di(meth)acrylate; butanediol di(meth)acrylate; tetraethylene glycol di(meth)acrylate; polyethylene glycol di(meth)acrylate; dipropylene glycol diallyl ether; polyglycol diallyl ether; hydroquinone diallyl ether; trimethylolpropane tri(meth)acrylate; trimethylolpropane diallyl ether; pentaerythritol triallyl ether; allyl(meth)acrylate; triallyl cyanurate; diallyl maleate; polyallyl esters; tetraallyloxyethane; triallylamine; tetraallylethylenediamine; divinyl benzene; glycidyl (meth)acrylate; 1,7-octadiene; 1,9-decadiene; 1,13-tetradecadiene; divinylbenzene; diallyl phthalate; triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-

trione; N,N'-divinylimidazolidone; 1-vinyl-3(E)-ethylidene pyrrolidone; 2,4,6-triallyloxy-1,3,5-triazine; and combinations thereof.

**[0059]** Particularly, the crosslinker(s) can be present in an amount from about 0.001 % by weight to about 10 % by weight of the polymer. Other non-limiting percentages would include 0.001 wt. % to about 7 wt. %, or about 0.001 % by weight to about 5 % by weight.

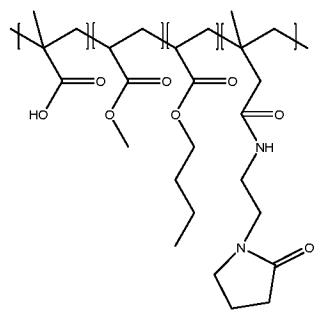
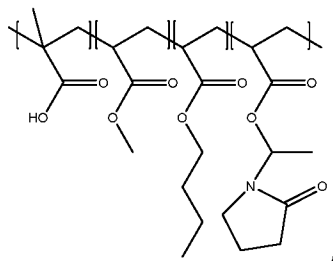
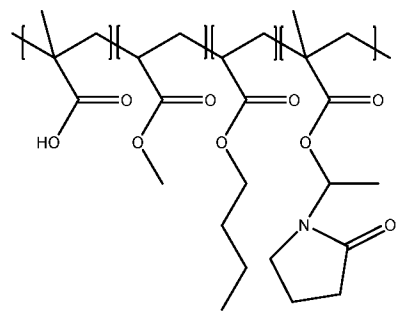
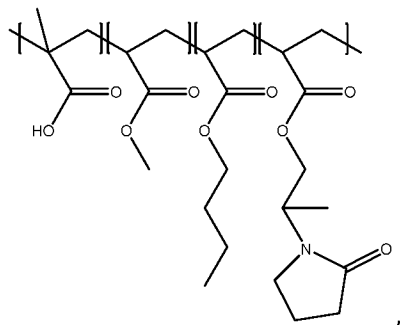
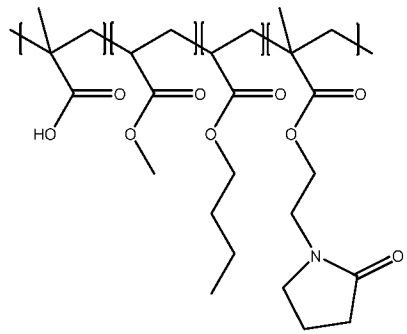
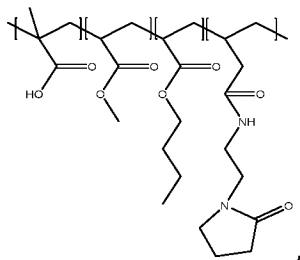
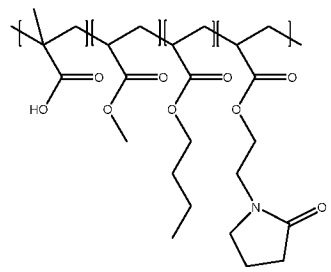
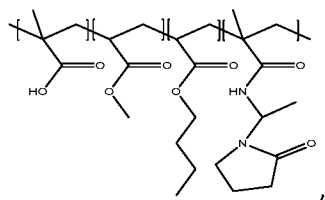
**[0060]** The present application also relates to a hair styling polymer derived from polymerizing: (a) about 0.1 to 50% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 5 to 80% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk) acrylates; (c) about 1 to 50% by weight of at least one functionalized/ unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; (d) about 0 to 5% by weight of at least one crosslinking agent.

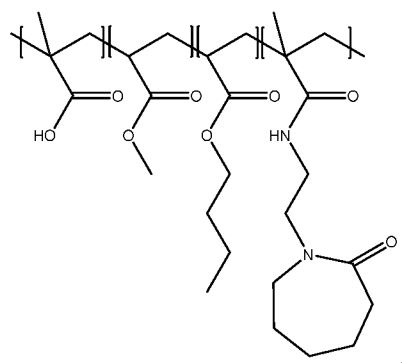
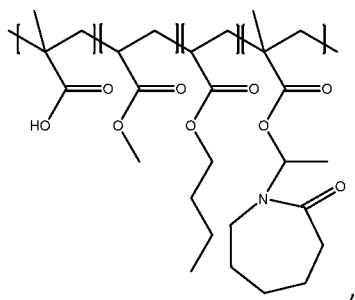
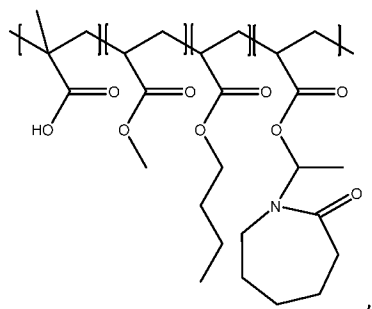
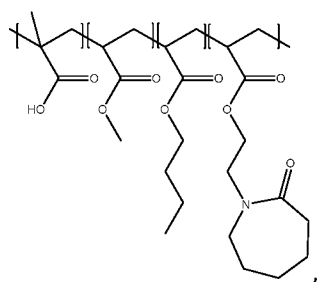
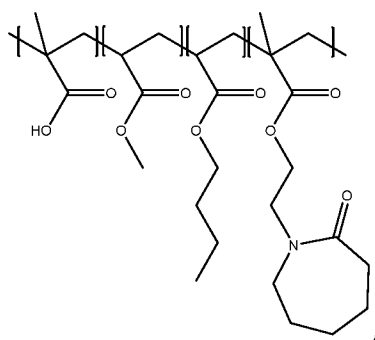
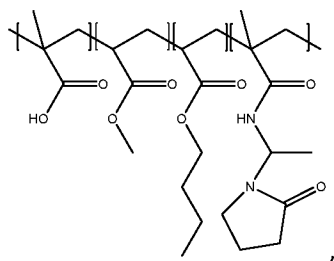
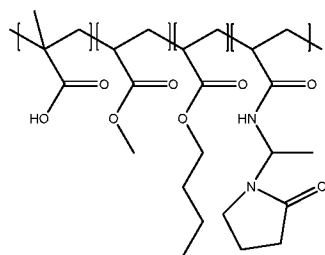
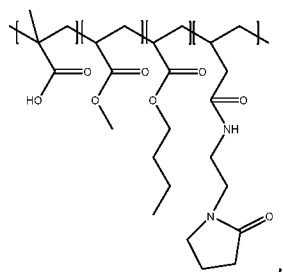
**[0061]** The present application also relates to a hair styling polymer derived from polymerizing: (a) about 0.1 to 50% by weight of at least one monomer having **CAS No: 946-25-8** comprising at least one functionalized or unfunctionalized acryloyl moiety having **CAS No: 946-25-8** and at least one lactam moiety having the structure:

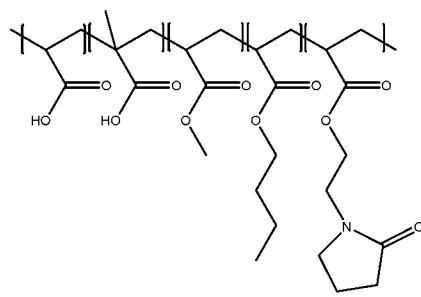
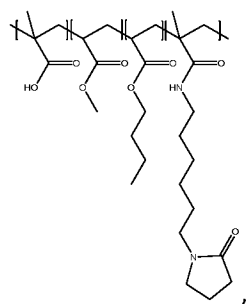
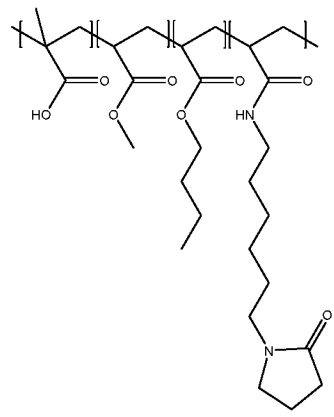
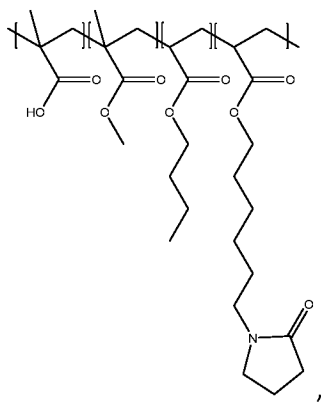
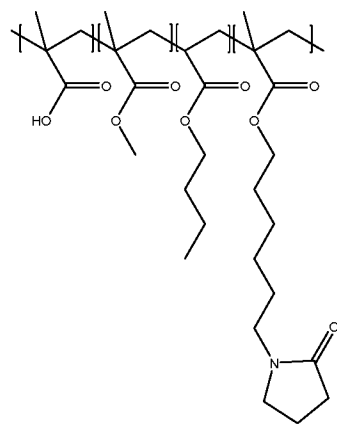
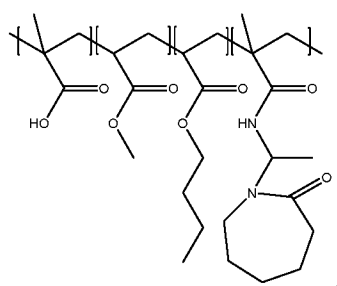
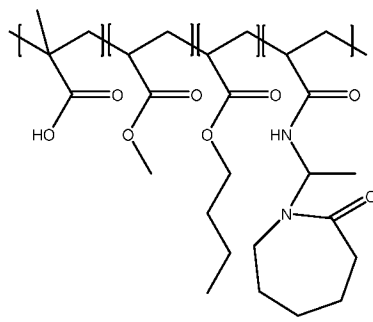
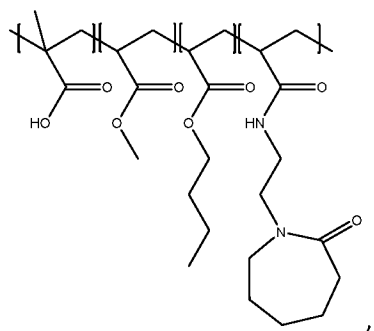


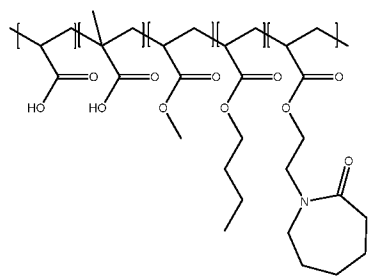
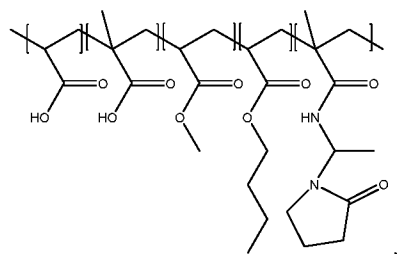
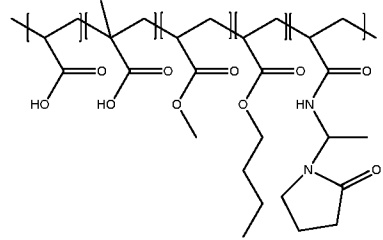
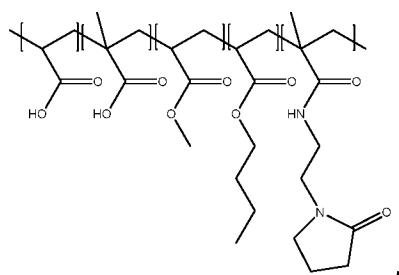
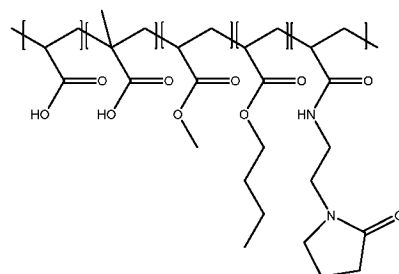
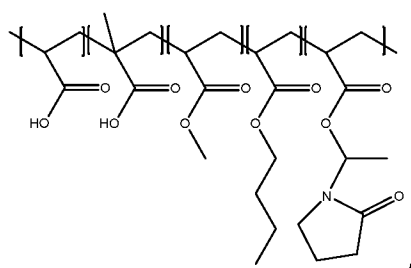
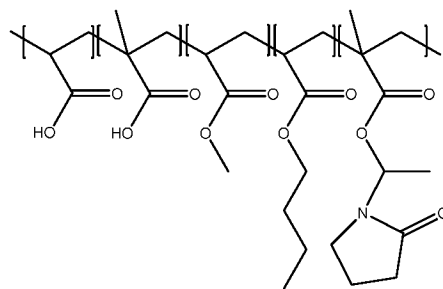
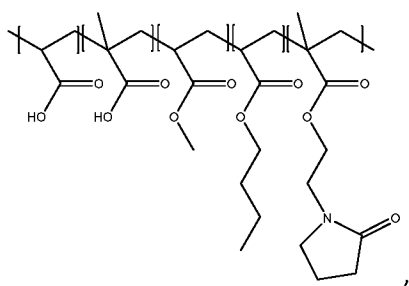
(b) about 10 to 75% by weight of methyl acrylate and butyl acrylate; (c) about 1 to 50% by weight of methacrylic acid; and (d) about 0 to 5% by weight of pentaerythritol triallyl ether (PETE).

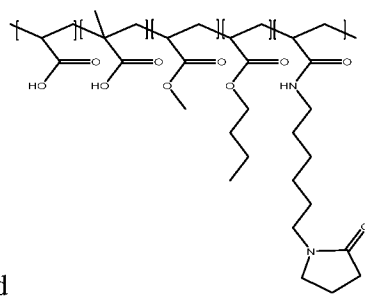
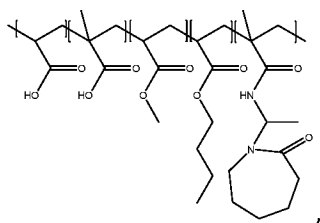
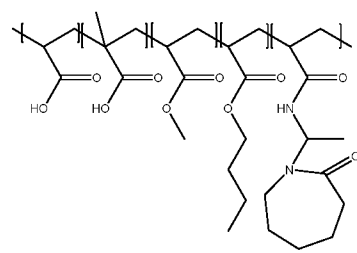
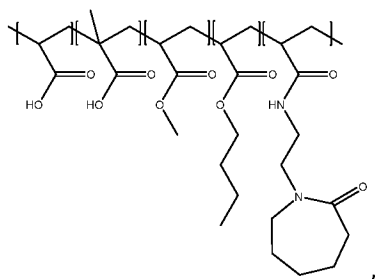
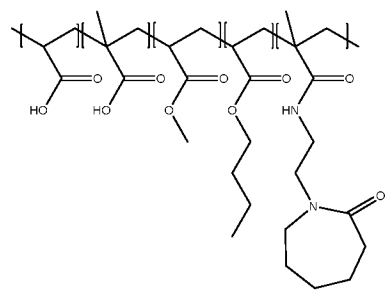
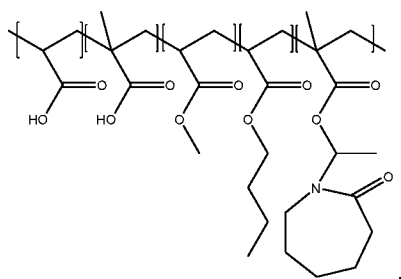
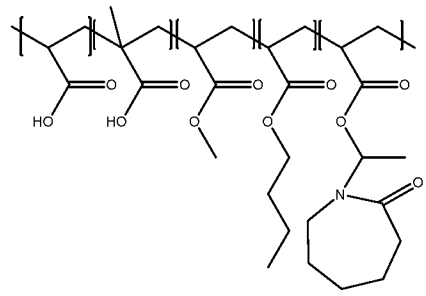
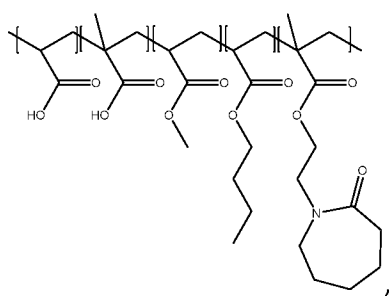
**[0062]** According to one important and non-limiting embodiment of the present application, the hair styling polymer is selected from those having the following specific structures and wherein, the styling polymer further optionally comprises at least one crosslinking agent as described in other embodiments of this application.











and

**[0063]** According to the current application, the average viscosity of the hair styling polymer is in the range of 50 - 100,000 *cPs*. Other non-limiting range would include 50 - 50,000 *cPs*, and 50 - 40,000 *cPs*.

[0064] The polymerization method(s) employed to prepare a polymer of the present application includes methods that are known in the prior art for a person skilled in the pertinent art. Particularly, the polymerization is carried out by any one of the methods disclosed in "*Principles of Polymerization*" 4<sup>th</sup> edition, 2004, Wiley by George Odian and is referred and disclosed herein in its entirety. Further, the polymerization of terpolymer or tetrapolymer of the present application can contain a suitable catalyst or initiators such as amines, bases, organic acids and/or photo-initiators. However, the preferred polymerization technique employed to prepare a conditioning polymer would include but not limited to radical polymerization, emulsion polymerization, ionic chain polymerization, bulk polymerization, suspension polymerization or precipitation polymerization.

[0065] The present application also relates to a hair styling composition comprising: (i) a hair styling polymer derived from polymerizing: (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one functionalized/unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to about 5% by weight of at least one crosslinking agent; and (ii) one or more cosmetically acceptable additives.

[0066] As used herein, the term "cosmetically acceptable additive" or "additional ingredients" means any ingredient/compound or mixture of ingredients/compounds or compositions that are typically employed to produce other desirable effects in personal care compositions. The preferred cosmetically acceptable additives include but not limited to preservatives, auxiliary fixing agents, emulsion stabilizers, sequestering agents, acidifying or basifying agents, fillers, emulsifying agents, UV-A or UV-B blocker/filters antioxidants, chelating agents, silicones, sunscreen agents, proteins, amino acids, vitamins, dyes, coloring agents, natural plant extracts, plant derivatives, plant tissue extracts, peptides, plant seed extracts, plant oils, botanicals, botanical extracts, humectants, fragrances, perfumes, oils, emollients, lubricants, butters, penetrants, thickeners, viscosity modifiers, polymers, resins, hair fixatives, film formers, surfactants, detergents, emulsifiers, opacifying agents, volatiles, propellants, liquid vehicles, carriers, salts, pH adjusting agents, neutralizing agents, buffering agents, hair conditioning agents, anti-static agents,

anti-frizz agents, anti-dandruff agents, hair waving agents, hair straightening agents, relaxers, absorbents, fatty substances, gelling agents, hydrophilic or lipophilic active agent, preserving agents, fillers, dyestuffs, reducing agents, cosmetic oils, perfumes, liquid vehicles, moisturizers, solvents, carriers, and combinations thereof.

**[0067]** It is contemplated to employ at least one personal care active ingredient for preparing a hair styling composition of the present application comprising a hair styling polymer and at least one cosmetically acceptable agent, wherein, the preferred personal care agent of the present application would include, but it is not limited to, carnitine, betain aminoacids, such as, *i.e.*, valine, glycine, arginine, allantoin, tocopherol nicotinate, niacinamide, retinyl propionate, palmitoyl-gly-his-lys, phytosterol, polyphenolic compounds, flavonoids, flavones, flavonols, isoflavone, dexpanthenol, panthenol, bisabolol, farnesol, phytantriol, salicylic acid, zinc/sodium pyridinethione salts, piroctone olamine, selenium disulfide, tetrahydrocurcumin, glucosamine, N-acetyl glucosamine, vitamin B3, retinoids, peptides, phytosterol, dialkanoyl hydroxyproline, hexamidine, salicylic acid, N-acyl amino acids, escorols, sunscreen actives, UV-A/UV-B protecting agent, UV filters, water soluble vitamins, oil soluble vitamins, hesperedin, mustard seed extract, glycyrrhizic acid, glycyrrhetic acid, carnosine, butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA), ergothioneine, vanillin, vanillin derivatives, diethylhexyl syrinylidene malonate, melanostatine, sterol esters, fatty acids, poly-unsaturated fatty acids, anti-fungal agents, thiol compounds, N-acetyl cysteine, glutathione, thioglycolate,  $\beta$ -carotene, ubiquinone, amino acids, idebenone, dehydroacetic acid, licohalcone A, creatine, creatinine, feverfew extract, yeast extract, beta glucans, alpha glucans, alone or in combination.

**[0068]** The effective amount of cosmetically acceptable additive employed in the present application is in the range of from about 0.01 wt. % to about 10 wt. %, preferably about 0.1 wt. % to about 5.0 wt. % and more preferably in the range of 0.05 wt. % to about 3.0 wt. % of the total composition.

**[0069]** Suitable viscosity modifiers and thickeners include synthetic and semi-synthetic viscosity modifiers. Exemplary synthetic viscosity modifiers include acrylic based polymers and copolymers. One class of acrylic based viscosity modifiers are the carboxyl functional alkali-swellaable and alkali-soluble thickeners (ASTs) produced by the free-

radical polymerization of acrylic acid alone or in combination with other ethylenically unsaturated monomers. Another class is hydrophobically modified alkali-swellaable and alkali-soluble emulsion (HASE) polymers. Examples of useful thickening agents include carboxyvinyl polymers, carrageenan, hydroxyethyl cellulose, hydrophobically modified hydroxy-ethyl-cellulose, laponite and water soluble salts of cellulose ethers such as sodium carboxymethylcellulose and sodium carboxymethyl hydroxyethyl cellulose, copolymers of lactide and glycolide monomers, carbomers. Natural gums such as gum karaya, xanthan gum, gum arabic, guar, HP guar, and gum tragacanth can also be used. These polymers are more fully described in US Patent No. 5087445; US Patent No. 4509949, US3657175; US4384096; US4464524; US4801671; and US5292843; US Patent No. 7205271 and US Patent No. 2798053, herein incorporated by reference in its entirety.

**[0070]** Suitable surfactants or surfactant systems for preparing a hair styling composition comprising a styling copolymer of the present application can be selected from anionic, non-ionic, amphoteric, cationic and mixtures thereof.

**[0071]** Suitable emulsifiers include the following classes of ethers and esters: ethers of polyglycols and of fatty alcohols, esters of polyglycols and of fatty acids, ethers of polyglycols and of fatty alcohols which are glycosylated, esters of polyglycols and of fatty acids which are glycosylated, ethers of C12-30 alcohols and of glycerol or of polyglycerol, esters of C12-30 fatty acids and of glycerol or of polyglycerol, ethers of oxyalkylene-modified C12-30 alcohols and of glycerol or polyglycerol, ethers of C12-30 fatty alcohols comprising and of sucrose or of glucose, esters of sucrose and of C12-30 fatty acids, esters of pentaerythritol and of C12-30 fatty acids, esters of sorbitol and/or of sorbitan and of C12-30 fatty acids, ethers of sorbitol and/or of sorbitan and of alkoxylated sorbitan, ethers of polyglycols and of cholesterol, esters of C12-30 fatty acids and of alkoxylated ethers of sorbitol and/or sorbitan, and combinations thereof. Linear or branched type silicone emulsifiers may also be used. Suitable emulsifying silicone elastomers may include at least one polyalkyl ether or polyglycerolated unit.

**[0072]** Suitable antioxidants may be added to facilitate the enhanced shelf-life of the personal care composition.

**[0073]** The hair styling composition of present application can be preserved by adding a minor quantity of one or more preservative agents to the compositions. Such preservative agents can be selected from, but are not limited to, triazoles, imidazoles, naphthalene derivatives, benzimidazoles, morphline derivatives, dithiocarbamates, benzisothiazoles, benzamides, boron compounds, formaldehyde donors, isothiazolones, thiocyanates, quaternary ammonium compounds, iodine derivatives, phenol derivatives, micobicides, pyridines, dialkylthiocarbamates, nitriles, parabens, benzoic acid, sorbic acid, salicylic acid, alkyl parabens and salts thereof.

**[0074]** Particularly, the fatty substance based excipient for the present application may include fatty alcohols, natural and synthetic waxes, ceramides, mineral oils, vegetable oils, animal oils, synthetic oils. Other fatty substance include isododecane, hydrogenated polyisobutene, squalane, isononyl isononanoate, cyclotetra- and - pentadimethicones, phenyltrimethicone, ethylene homopolymers, ethoxylated fats and oils, fluoroalkanes, seracite, shea butter, arachidyl propionate alone or in combination. For the definition of waxes, mention may be made, for example, of P. D. Dorgan, Drug and Cosmetic Industry, December 1983, pp. 30-33.

**[0075]** The animal or plant oils are preferably chosen from sunflower oil, corn oil, soybean oil, avocado oil, jojoba oil, marrow oil, argan oil, grapeseed oil, sesame oil, hazelnut oil, fish oils, glyceryl tricaprocaprylate, or plant or animal oils of formula  $R_1COOR_2$  in which  $R_1$  represents a higher fatty acid residue containing from 7 to 29 carbon atoms and  $R_2$  represents a linear or branched hydrocarbon-based chain containing from 3 to 30 carbon atoms, particularly alkyl or alkenyl, for example purcellin oil or liquid jojoba wax. Further, it is also possible to use natural or synthetic essential oils such as, for example, eucalyptus oil, lavandin oil, lavender oil, vetiver oil, Litsea cubeba oil, lemon oil, sandalwood oil, rosemary oil, camomile oil, savory oil, nutmeg oil, cinnamon oil, hyssop oil, caraway oil, orange oil, geraniol oil, cade oil, almond oil, argan oil, avocado oil, olive oil, sun flower oil, cedar oil, wheat germ oil and bergamot oil.

**[0076]** Moisturizers employed in the present application would include glycols, glycerols, propylene glycol, diethylene glycol monoethyl ether, sorbitol, sodium salt of pyroglutamic acid, glycerol, glycerol derivatives, glycerin, trehalose, sorbitol, maltitol, dipropylene glycol, 1,3-butylene glycol, sodium hyaluronate, and the like.

[0077] Further, it is known that moisturizers that bind well with water, thereby retaining it on the hair surface are called humectants. Examples of humectants which can be incorporated into a product of the present application are glycerine, propylene glycol, polypropylene glycol, polyethylene glycol, lactic acid, sodium lactate, pyrrolidone carboxylic acid, urea, phospholipids, collagen, elastin, ceramides, lecithin sorbitol, PEG-4, and mixtures thereof. Additional suitable moisturizers are polymeric moisturizers that belong to water soluble and/or water swellable in nature. Polysaccharides such as hyaluronic acid, chitosan can also be employed along with moisturizers of the present application as binders to enhance this property.

[0078] The solvent of the present application can consist of water, a cosmetically acceptable solvent, or a blend of water and a cosmetically acceptable solvent, such as a lower alcohol composed of C<sub>1</sub> to C<sub>4</sub>, such as ethanol, isopropanol, *t*-butanol, *n*-butanol, alkylene glycols such as propylene glycol, and glycol ethers. However, the compositions can be anhydrous. The particular solvents of the present application include water, ethanol and/or iso-propanol.

[0079] The neutralizing agents that can be included in the product of the present application to neutralize components, such as, *e.g.*, an emulsifier or a foam builder/stabilizer, include but are not limited to alkali hydroxides such as a sodium and potassium hydroxide; organic bases such as methylethylamine (MEA), ammonia, aminoalcohols, lithium hydroxide, diethanolamine (DEA); triethanolamine (TEA), aminomethyl propanol, and mixtures thereof; amino acids such as arginine and lysine and any combination of any foregoing. The suitable acidic neutralizing agent that can be employed in the present application include, but are not limited to, mineral acids, carboxylic acids and polymeric acids. The neutralizing agent can be present in an amount of about 0.01 wt. % to about 8 wt. %, particularly, 1 wt. % to about 5 wt. %.

[0080] Suitable buffering agents include, but are not limited to, alkali or alkali earth carbonates, phosphates, bicarbonates, citrates, borates, acetates, acid anhydrides, succinates and the like, such as sodium phosphate, citrate, borate, acetate, bicarbonate, and carbonate.

[0081] Examples of anti-dandruff agents that can be used are cimbazole, octopirox, zinc pyrithione, salicylic acid, elemental sulfur, selenium dioxide, and the azole antimycotics.

[0082] According to one important embodiment of the present application, it is contemplated to employ natural plant extracts showing hair conditioning, restructuring effects and growing effects. Those are preferably selected from almond, coconut, mango, peach, lemon, wheat, rosemary, apricot, algae, grapefruit, sandalwood, lime orange, *Acacia concinna*, *Butea parviflora*, *Butea superb*, *Butea frondosa* and/or *Aloe Vera*. The extracts of these plants are obtained from seeds, roots, stem, leaves, flowers, bark, fruits, and/or whole plant.

[0083] According to one important embodiment of the present application, it is contemplated to employ at least one organic UV filters which can filter out UV rays can be selected from hydrosoluble or liposoluble filters, whether siliconated or nonsiliconated, and mineral oxide particles, the surface of which may be treated.

[0084] The coloring agents, colorants or dyes used herein include natural foods colors and dyes suitable for food, drug and cosmetic applications. These colorants are also known as FD & C, and D&C dyes and lakes and are preferably water-soluble in nature. A full recitation of all FD&C and D&C dyes and their corresponding chemical structures can be found in the Kirk-Othmer Encyclopedia of Chemical Technology, Volume 5, pages 857-884, which text is accordingly incorporated herein by reference. These coloring agents can be incorporated in amount up to about 3%, more particularly up to about 2%, and in some cases less than about 1% by weight of the personal care compositions.

[0085] A perfume or fragrance obtained from natural or synthetic source can be employed in the present personal care composition. The fragrance can be used along with a suitable solvent, diluents or carrier. Fragrances can be added in any conventionally known method, for example, admixing to a composition or blending with other ingredients used to form a composition, in amounts which are found to be useful to increase or impart the desired scent characteristics to the disinfectant or cleaning compositions. Fragrances for the present application can be one or more selected from the following non-limiting group of compounds such as essential oils, absolutes, resinoids, resins, concretes, hydrocarbons, alcohols, aldehydes, ketones, ethers, acids, esters, acetals, ketals, nitriles, including saturated and unsaturated compounds and aliphatic, carbocyclic and heterocyclic compounds.

**[0086]** According to one embodiment of the present application, the styling composition optionally comprises any silicones which are known to a person skilled in the art, such silicones may be present in the form of oils, waxes, resins, or gums. The organo-modified silicones suitable for use in the invention include silicones such as those previously defined and containing one or more organofunctional groups attached by means of a hydrocarbon radical and grafted siliconated polymers. Particularly preferred are amino functional silicones. The silicones may be used in the form of emulsions, nano-emulsions, or micro-emulsions. Silicones for the present invention can be selected from Encyclopedia of Polymer Science and Engineering, vol. 15, 2d ed., pp 204-308, John Wiley & Sons, Inc. (1989), the disclosure of which is incorporated herein by reference. Non-limiting examples of suitable silicone conditioning agents, and optional suspending agents for the silicone, are described in detail in US Reissue Patent No. 34584, US Patent No. 5104646, and US Patent No. 5106609.

**[0087]** Another embodiment of the present application provides a method of treating or fixing regular or damaged hair substrate comprising contacting said hair substrate with an effective amount of hair care composition comprising (i) a hair styling polymer of (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to 5% by weight of at least one crosslinking agent; and (ii) one or more of cosmetically acceptable additives

**[0088]** The effective amount of styling polymer required for a hair styling composition to treating or fixing regular or damaged hair substrate is in the range of from about 0.01 wt. % to about 10 wt. %, and particularly in the range of from about 0.1 wt. % to about 5.0 wt. % of the total composition.

**[0089]** The styling polymer is preferably present in the hair care composition in a hair-styling effective amount, e.g., in an amount effective to promote at least about 90% curl retention in the hair for a period from 6 to 12 hours under conditions of about 90% relative humidity and a temperature about 24°C, when the composition is applied to human hair.

**[0090]** The polymer according to the current application feasibly can be customized to meet the ever challenging hair styles. The polymer provides excellent styling properties, stiffness, stiffness durability, non-sticky, retain curl even at high humid conditions. Inventive fixative polymers are formulated according to preference by altering the concentration and pH.

**[0091]** The hair styling composition of present application can be an appropriate product selected from the group consisting of hair-care products, shampoos, hair conditioners, 2 in 1 shampoos, leave in and rinse off conditioners, hair treatments including intensive treatments, styling and treating hair compositions, hair perming products, hair straighteners, hair relaxants, hair sprays and lacquers, permanent hair dyeing systems, hair styling mousses, hair gels, semi-permanent hair dyeing systems, temporary hair dyeing systems, hair bleaching agents, permanent hair wave systems, hair setting formulations, non-coloring hair preparations, hair-frizz-control gels, hair leave-in conditioners, hair pomades, hair de-tangling products, hair fixatives, hair conditioning mists, hair care pump sprays and other non-aerosol sprays.

**[0092]** The hair styling composition of present application can be formulated in several required forms according to their necessity, and the non-limiting forms include emulsion, lotion, gel, vesicle dispersion, paste, cream, solid stick, mousse, shampoo, spray, balm, wipe, milk, foam, jellies, liquid, and/or enamel.

**[0093]** Further, certain aspects of the present invention are illustrated in detail by way of the following examples. The examples are given herein for illustration of certain aspects of the invention and are not intended to be limiting thereof.

## EXAMPLES

**[0094] Example 1:** Polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA)/Acrylic acid (AA) and N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06) (85/15):

**[0095]** A representative emulsion polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA)/Acrylic acid (AA) / N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06), at an acrylate to M-06 monomer ratio of 85/15 was prepared as follows: the reactor vessel was charged with deionized water (356 g) and degassed with nitrogen for 1 h at room temperature. In a separate beaker, deionized water (340 g) was stirred with the surfactant, Disponil SDS-G (3.0 g) at room temperature, using an overhead stirrer. The monomer mixture was prepared in a fume hood and contained methyl acrylate (MA, 36 wt%), butyl acrylate (BA, 19 wt%), acrylic acid (AA, 9 wt%), methacrylic acid (MAA, 21 wt%) and M-06 (15 wt%). After 1 h of degassing the aqueous solution in the reactor vessel, the temperature was heated to 85 °C, the nitrogen flow was reduced and raised above the solution to maintain an inert atmosphere. The surfactant, Disponil SDS-G (3 g) was added to the reactor solution. At this point, the overhead stirrer was initialized. The cross-linker, pentaerythritol triallyl ether (PETE, 300 ppm) and the monomer mixture were charged into the stirred aqueous solution, homogenized outside of the reactor, at room temperature. The emulsion was allowed to homogenize for 10 minutes. In the meantime, the initiator shot and feed containing ammonium persulfate (APS) were prepared. The initiator shot containing 25% of the total initiator amount was dissolved in water (2 g) and prepared in a syringe. The initiator feed containing the remaining 75% of total initiator was dissolved in water (60 g) and was prepared in a beaker. Once the aqueous charge in the reaction had equilibrated to temperature, the initiator shot was added to the reactor and then both the initiator and monomer feeds were initialized. The initiator was fed in over 120 min, at a rate of 0.5 mL/min and the monomer over 90 min, at a rate of 7 mL/min. After completion of both feeds, the polymerization was allowed to react for an additional hour. The polymerization was then allowed to cool to room temperature.

**[0096] Example 2:** Polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA) and Acrylic acid (AA):

**[0097]** A representative emulsion polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/ Methacrylic acid (MAA)/ and Acrylic acid (AA) was prepared as follows: the reactor vessel was charged with deionized water (356 g) and degassed with nitrogen for 1 h at room temperature. In a separate beaker, deionized water (340 g) was stirred with the surfactant, Disponil SDS-G (3.0 g) at room temperature, using an overhead stirrer. The monomer mixture was prepared in a fume hood and contained methyl acrylate (MA, 42.25 wt%), butyl acrylate (BA, 22.75 wt%), acrylic acid (AA, 10.5 wt%), methacrylic acid (MAA, 24.5 wt%). After 1 h of degassing the aqueous solution in the reactor vessel, the temperature was heated to 85 °C, the nitrogen flow was reduced and raised above the solution to maintain an inert atmosphere. The surfactant, Disponil SDS-G (3 g) was added to the reactor solution. At this point, the overhead stirrer was initialized. The cross-linker, pentaerythritol triallyl ether (PETE, 300 ppm) and the monomer mixture were charged into the stirred aqueous solution, homogenized outside of the reactor, at room temperature. The emulsion was allowed to homogenize for 10 minutes. In the meantime, the initiator shot and feed containing ammonium persulfate (APS) were prepared. The initiator shot containing 25% of the total initiator amount was dissolved in water (2 g) and prepared in a syringe. The initiator feed containing the remaining 75% of total initiator was dissolved in water (60 g) and was prepared in a beaker. Once the aqueous charge in the reaction had equilibrated to temperature, the initiator shot was added to the reactor and then both the initiator and monomer feeds were initialized. The initiator was fed in over 120 min, at a rate of 0.5 mL.min<sup>-1</sup> and the monomer over 90 min, at a rate of 7 mL.min<sup>-1</sup>. After completion of both feeds, the polymerization was allowed to react for an additional hour. The polymerization was then allowed to cool to room temperature.

**[0098] Example 3:** Polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/ Methacrylic acid (MAA)/Acrylic acid (AA) and N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06) (85/15):

**[0099]** A representative emulsion polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/ Methacrylic acid (MAA)/Acrylic acid (AA) / N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06), at an acrylate to M-06 monomer ratio of 85/15 was prepared as follows: the reactor vessel was charged with deionized water (356 g) and degassed with nitrogen for 1 h at room temperature. In a separate beaker, deionized water (340 g) was stirred with the surfactant, Disponil SDS-G (3.0 g) at room temperature, using an overhead

stirrer. The monomer mixture was prepared in a fumehood and contained methyl acrylate (MA, 36 wt%), butyl acrylate (BA, 19 wt%), acrylic acid (AA, 9 wt%), methacrylic acid (MAA, 21 wt%) and M-06 (15 wt%). After 1 h of degassing the aqueous solution in the reactor vessel, the temperature was heated to 80 °C, the nitrogen flow was reduced and raised above the solution to maintain an inert atmosphere. The surfactant, Disponil SDS-G (3 g) was added to the reactor solution. At this point, the overhead stirrer was initialized. The cross-linker, pentaerythritol triallyl ether (PETE, 300 ppm) and the monomer mixture were charged into the stirred aqueous solution, homogenized outside of the reactor, at room temperature. The emulsion was allowed to homogenize for 10 minutes. In the meantime, the initiator shot and feed containing ammonium persulfate (APS) were prepared. The initiator shot containing 25% of the total initiator amount was dissolved in water (2 g) and prepared in a syringe. The initiator feed containing the remaining 75% of total initiator was dissolved in water (60 g) and was prepared in a beaker. Once the aqueous charge in the reaction had equilibrated to temperature, the initiator shot was added to the reactor and then both the initiator and monomer feeds were initialized. The initiator was fed in over 120 min, at a rate of 0.5 mL.min<sup>-1</sup> and the monomer over 90 min, at a rate of 7 mL.min<sup>-1</sup>. After completion of both feeds, the polymerization was allowed to react for an additional hour. The polymerization was then allowed to cool to room temperature.

**[00100] Example 4:** Polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA) and Acrylic acid (AA):

**[00101]** A representative emulsion polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA) and Acrylic acid (AA) was prepared as follows: the reactor vessel was charged with deionized water (356 g) and degassed with nitrogen for 1 h at room temperature. In a separate beaker, deionized water (340 g) was stirred with the surfactant, Disponil SDS-G (3.0 g) at room temperature, using an overhead stirrer. The monomer mixture was prepared in a fume hood and contained methyl acrylate (MA, 42.25 wt%), butyl acrylate (BA, 22.75 wt%), acrylic acid (AA, 10.5 wt%), methacrylic acid (MAA, 24.5 wt%). After 1 h of degassing the aqueous solution in the reactor vessel, the temperature was heated to 80 °C, the nitrogen flow was reduced and raised above the solution to maintain an inert atmosphere. The surfactant, Disponil SDS-G (3 g) was added to the reactor solution. At this point, the overhead stirrer was initialized. The cross-linker, pentaerythritol triallyl ether (PETE, 300 ppm) and the monomer mixture were charged into

the stirred aqueous solution, homogenized outside of the reactor, at room temperature. The emulsion was allowed to homogenize for 10 minutes. In the meantime, the initiator shot and feed containing ammonium persulfate (APS) were prepared. The initiator shot containing 25% of the total initiator amount was dissolved in water (2 g) and prepared in a syringe. The initiator feed containing the remaining 75% of total initiator was dissolved in water (60 g) and was prepared in a beaker. Once the aqueous charge in the reaction had equilibrated to temperature, the initiator shot was added to the reactor and then both the initiator and monomer feeds were initialized. The initiator was fed in over 120 min, at a rate of 0.5 mL.min<sup>-1</sup> and the monomer over 90 min, at a rate of 7 mL.min<sup>-1</sup>. After completion of both feeds, the polymerization was allowed to react for an additional hour. The polymerization was then allowed to cool to room temperature.

**[00102] Example 5:** polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA)/Acrylic acid (AA) and N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06) (85/15):

**[00103]** A representative emulsion polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA)/Acrylic acid (AA) / N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06), at an acrylate to M-06 monomer ratio of 85/15 was prepared as follows: the reactor vessel was charged with deionized water (356 g) and degassed with nitrogen for 1 h at room temperature. In a separate beaker, deionized water (340 g) was stirred with the surfactant, Disponil SDS-G (3.0 g) at room temperature, using an overhead stirrer. The monomer mixture was prepared in a fumehood and contained methyl acrylate (MA, 36 wt%), butyl acrylate (BA, 19 wt%), acrylic acid (AA, 9 wt%), methacrylic acid (MAA, 21 wt%) and M-06 (15 wt%). After 1 h of degassing the aqueous solution in the reactor vessel, the temperature was heated to 80 °C, the nitrogen flow was reduced and raised above the solution to maintain an inert atmosphere. The surfactant, Disponil SDS-G (3 g) was added to the reactor solution. At this point, the overhead stirrer was initialized. The cross-linker, pentaerythritol triallyl ether (PETE, 500 ppm) and the monomer mixture were charged into the stirred aqueous solution, homogenized outside of the reactor, at room temperature. The emulsion was allowed to homogenize for 10 minutes. In the meantime, the initiator shot and feed containing ammonium persulfate (APS) were prepared. The initiator shot containing 25% of the total initiator amount was dissolved in water (2 g) and prepared in a syringe. The initiator feed containing the remaining 75% of total initiator was

dissolved in water (60 g) and was prepared in a beaker. Once the aqueous charge in the reaction had equilibrated to temperature, the initiator shot was added to the reactor and then both the initiator and monomer feeds were initialized. The initiator was fed in over 120 min, at a rate of 0.5 mL.min<sup>-1</sup> and the monomer over 90 min, at a rate of 7 mL.min<sup>-1</sup>. After completion of both feeds, the polymerization was allowed to react for an additional hour. The polymerization was then allowed to cool to room temperature.

**[00104] Example 6:** Polymerization of Methyl acrylate(MA)/Butyl crylate(BA)/Methacrylic acid (MAA)/Acrylic acid (AA) and N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06) (90/10):

**[00105]** A representative emulsion polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/ Methacrylic acid (MAA)/Acrylic acid (AA)/ N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06), at an acrylate to M-06 monomer ratio of 95/5 is as follows: the reactor vessel was charged with deionized water (356 g) and degassed with nitrogen (g) for 1 h at room temperature. In a separate beaker, deionized water (340 g) was stirred with the surfactant, Disponil SDS-G (3.0 g) at room temperature, using an overhead stirrer. The monomer mixture was prepared in a fume hood and contained methyl acrylate (MA, 38 wt%), butyl acrylate (BA, 20 wt%), acrylic acid (AA, 9 wt%), methacrylic acid (MAA, 22 wt%) and M-06 (10 wt%). After 1 h of degassing the aqueous solution in the reactor vessel, the temperature was heated to 80 °C, the nitrogen flow was reduced and raised above the solution to maintain an inert atmosphere. The surfactant, Disponil SDS-G (3 g) was added to the reactor solution. At this point, the overhead stirrer was initialized. The cross-linker, Pentaerythritol triallyl ether (PETE, 500 ppm) and the monomer mixture were charged into the stirred aqueous solution, homogenized outside of the reactor, at room temperature. The emulsion was allowed to homogenize for 10 minutes. In the meantime, the initiator shot and feed containing ammonium persulfate (APS) were prepared. The initiator shot containing 25% of the total initiator amount was dissolved in water (2 g) and prepared in a syringe. The initiator feed containing the remaining 75% of total initiator was dissolved in water (60 g) and was prepared in a beaker. Once the aqueous charge in the reaction had equilibrated to temperature, the initiator shot was added to the reactor and then both the initiator and monomer feeds were initialized. The initiator was fed in over 120 min, at a rate of 0.5 mL.min<sup>-1</sup> and the monomer over 90 min, at a rate of 7 mL.min<sup>-1</sup>. After

completion of both feeds, the polymerization was allowed to react for an additional hour. The polymerization was then allowed to cool to room temperature.

**[00106] Example 7:** Polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA)/Acrylic acid (AA) and N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06 (95/5):

**[00107]** A representative emulsion polymerization of Methyl acrylate(MA)/Butyl acrylate(BA)/Methacrylic acid (MAA)/Acrylic acid (AA)/N-(2-(methacryloyloxy)ethyl) pyrrolidone (M-06), at an acrylate to M-06 monomer ratio of 95/5 was prepared as follows: the reactor vessel was charged with deionized water (356 g) and degassed with nitrogen for 1 h at room temperature. In a separate beaker, deionized water (340 g) was stirred with the surfactant, Disponil SDS-G (3.0 g) at room temperature, using an overhead stirrer. The monomer mixture was prepared in a fume hood and contained methyl acrylate (MA, 40 wt%), butyl acrylate (BA, 22 wt%), acrylic acid (AA, 10 wt%), methacrylic acid (MAA, 23 wt%) and M-06 (5 wt%). After 1 h of degassing the aqueous solution in the reactor vessel, the temperature was heated to 80 °C, the nitrogen flow was reduced and raised above the solution to maintain an inert atmosphere. The surfactant, Disponil SDS-G (3 g) was added to the reactor solution. At this point, the overhead stirrer was initialized. The cross-linker, pentaerythritol triallyl ether (PETE, 500 ppm) and the monomer mixture were charged into the stirred aqueous solution, homogenized outside of the reactor, at room temperature. The emulsion was allowed to homogenize for 10 minutes. In the meantime, the initiator shot and feed containing ammonium persulfate (APS) were prepared. The initiator shot containing 25% of the total initiator amount was dissolved in water (2 g) and prepared in a syringe. The initiator feed containing the remaining 75% of total initiator was dissolved in water (60 g) and was prepared in a beaker. Once the aqueous charge in the reaction had equilibrated to temperature, the initiator shot was added to the reactor and then both the initiator and monomer feeds were initialized. The initiator was fed in over 120 min, at a rate of 0.5 mL.min<sup>-1</sup> and the monomer over 90 min, at a rate of 7 mL.min<sup>-1</sup>. After completion of both feeds, the polymerization was allowed to react for an additional hour. The polymerization was then allowed to cool to room temperature.

**[00108] Example 8: Hair Care Compositions:**

**[00109] Styling gel:** The polymer prepared according to Example 1-7 were formulated separately into consumer formulations; specific hair styling gel is given below:

Hair styling gel composition

| Material                                                             | %<br>Weight |
|----------------------------------------------------------------------|-------------|
| Disodium EDTA                                                        | 0.05        |
| Amino methyl Propanol                                                | 0.03        |
| Polymer according to Example 3                                       | 2.0         |
| Acrylic Acid Copolymer                                               | 0.25        |
| Fragrance                                                            | 1.50        |
| propylene glycol, diazolidinyl urea &<br>iodopropynyl butylcarbamate | 0.50        |
| Water                                                                | 95.67       |

**[00110] Example 9: High Humidity Curl Retention (HHCR):**

**[00111]** The HHCR test measures the percent curl retention of hair tresses, in 90% relative humidity at 25 °C, as a function of time. This is a test performed by wrapping hair tresses around rollers in an overlapping configuration, allowing them to dry, and then carefully removing the tresses from the roller. The dried curled tresses are hung in a humidity cabinet and evaluated for curl droop over time. The curl retention test is a measure of the relative strengths of the hair and the fixative polymer, which oppose one another as the hair tress is driven to return to its natural configuration. In a more stringent test, the hair tresses were carefully wrapped around spiral curling rods so as not to twist the hair. The curled tresses were carefully removed from the spiral curling rods and placed in a humidity chamber, controlled at 50% & 90% RH. Measurements were taken at regular time intervals to determine the effect of humidity on curl retention. The per cent spiral curl retention was determined by the formula used for traditional HHCR test:

**[00112]** % curl retention =  $(L - L_t) / (L - L_o) * 100$ ; wherein L is the total length of the hair tress.

**[00113]** L is the length of the tress at the time interval observed and L<sub>o</sub> is the initial length of the curled tress at the start of the test. The results obtained are described in the

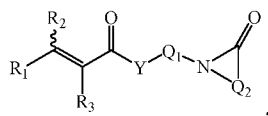
Figure 1 below where it can be seen that the hair swatch treated with the inventive styling polymer yields a high humidity curl retention (HHCR) effect that lasted for about 12 hours.

[00114] While this application described in detail with reference to certain preferred embodiments, it should be appreciated that the present application is not limited to those precise embodiments. Rather, in view of the present disclosure, many modifications and variations would present themselves to those skilled in the art without departing from the scope and spirit of this invention.

What is claimed is:

1. A hair styling polymer derived from polymerizing:
  - (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety;
  - (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates;
  - (c) about 0.1 to 99.9% by weight of at least one functionalized or unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and
  - (d) 0 to 5 % by weight of at least one crosslinking agent.

2. The hair styling polymer according to claim 1 wherein said monomer having at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety has the structure:



wherein each  $R_1$ ,  $R_2$  and  $R_3$  is independently selected from the group consisting of

hydrogen, halogens, functionalized and unfunctionalized  $C_1$ - $C_4$  alkyl, and  $\text{—}\overset{\text{O}}{\parallel}\text{C—X}$ ;

each X is independently selected from the group consisting of OR<sub>4</sub>, OM, halogen,

$\text{N(R}_5\text{)(R}_6\text{)}$ ,  $\text{—Y—Q}_3\text{—N}$  (where N is part of a lactam ring with a carbonyl group and a Q<sub>4</sub> group), and combinations thereof;

each Y is independently oxygen, NR<sub>7</sub> or sulfur;

each R<sub>4</sub>, R<sub>5</sub>, R<sub>6</sub> and R<sub>7</sub> is independently selected from the group consisting of hydrogen and functionalized and unfunctionalized alkyl;

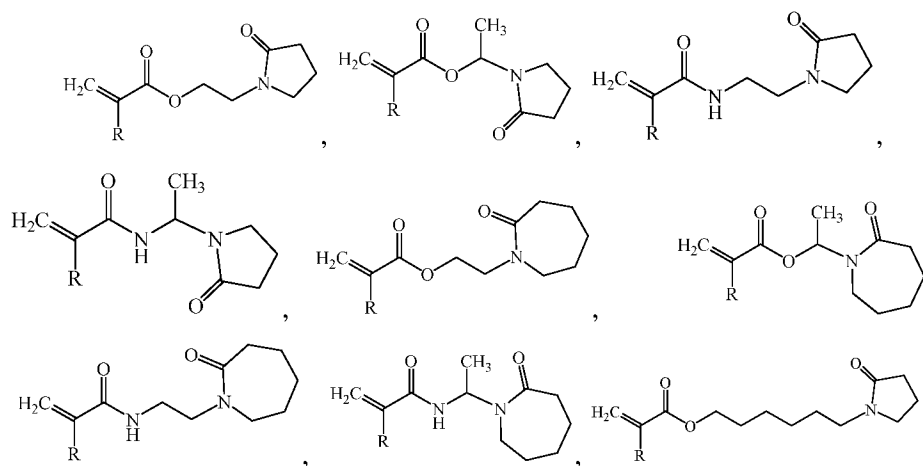
each M is independently selected from the group consisting of metal ions, ammonium ions, organic ammonium cations, and combinations thereof;

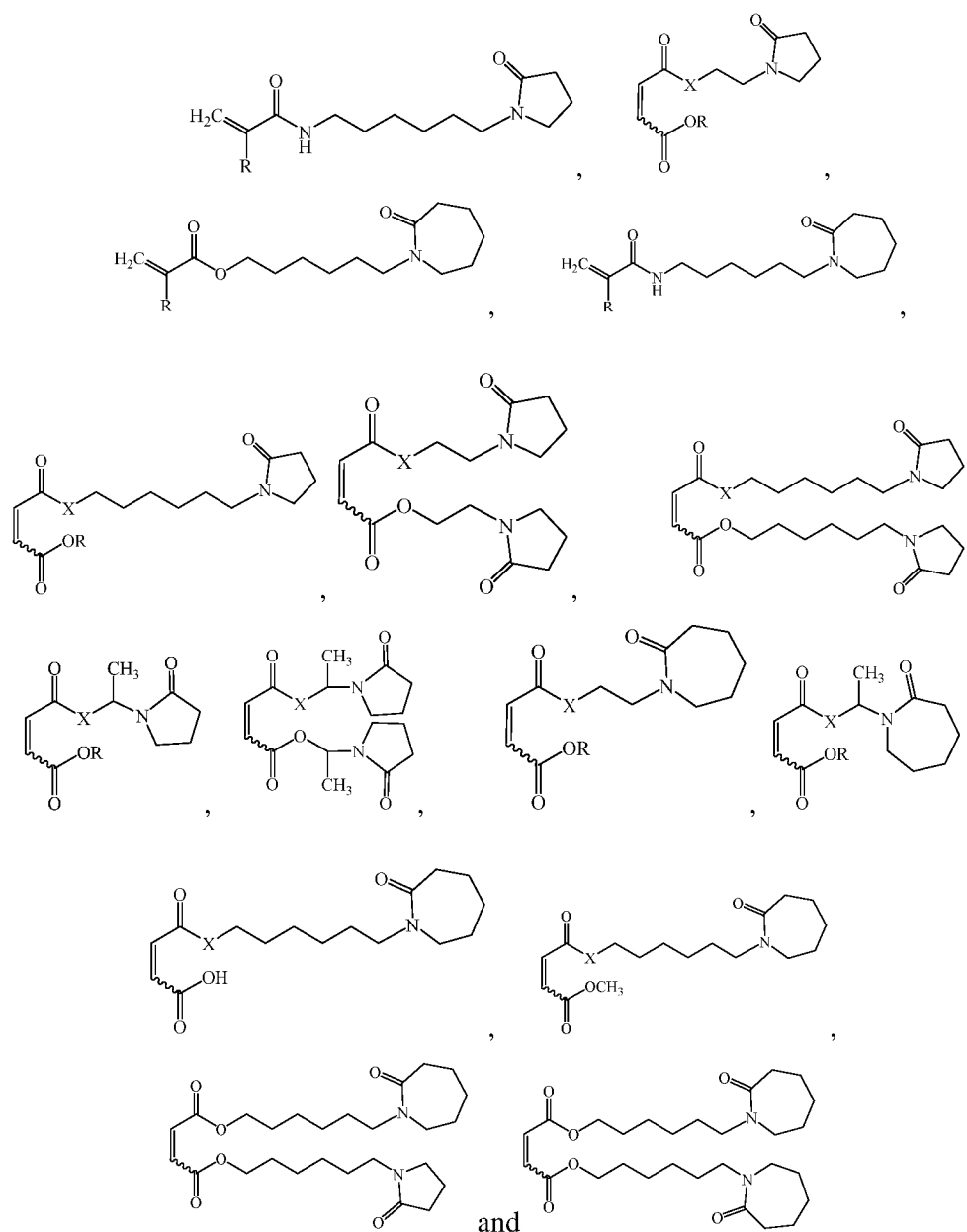
and each Q<sub>1</sub>, Q<sub>2</sub>, Q<sub>3</sub>, and Q<sub>4</sub> is independently selected from the group consisting of functionalized and unfunctionalized alkylene.

3. The hair styling polymer according to claim 2 wherein each said Q<sub>1</sub>, Q<sub>2</sub>, Q<sub>3</sub>, and Q<sub>4</sub> is independently selected from the group consisting of functionalized and unfunctionalized C<sub>1</sub> – C<sub>12</sub> alkylene.

4. The hair styling polymer according to claim 2 wherein each said R<sub>1</sub> and R<sub>3</sub> is independently hydrogen or methyl; said R<sub>2</sub> is  $\text{---}\overset{\text{O}}{\parallel}{\text{C}}\text{---X}$ ; X is selected from the group consisting of OR<sub>4</sub>, OM, halogens, and N(R<sub>5</sub>)(R<sub>6</sub>); each R<sub>4</sub>, R<sub>5</sub>, and R<sub>6</sub> is independently selected from the group consisting of hydrogen and functionalized and unfunctionalized alkyl; and each M is independently selected from the group consisting of metal ions, ammonium ions, organic ammonium cations, and combinations thereof.

5. The hair styling polymer according to claim 2 wherein said monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety has a structure selected from the group consisting of:





6. The hair styling polymer according to claim 1, wherein said monomer having at least one functionalized or unfunctionalized alkyl (alk)acrylates group is selected from the group consisting of (meth)acrylate, ethyl acrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate, butyl acrylate, *tert*-butyl acrylate, hexyl acrylate, 2-ethylhexyl acrylate, lauryl acrylate, ethyl acrylate, ethylene glycol diacrylate, triethylene glycol diacrylate, tripropylene glycol diacrylate, 1,4-butanediol diacrylate and

dimethacrylate, neopentyl glycol acrylate, neopentyl glycol methacrylate, 1,6-hexanediol diacrylate, 1,6-hexanediol dimethacrylate, 1,12-dodecanediol dimethacrylate, ethylene glycol dimethacrylate, diethylene glycol dimethacrylate, 2-ethylhexyl methacrylate, hexyl methacrylate, lauryl methacrylate, cyanoacrylate, polyethylene glycol diacrylate, polyethylene glycol dimethacrylate, polypropylene glycol diacrylate, polypropylene glycol dimethacrylate and combinations thereof.

7. The hair styling polymer according to claim 1, wherein said olefinically-unsaturated acid monomer is selected from the group consisting of a functionalized/unfunctionalized carboxylic acid-containing vinyl monomer, a functionalized/unfunctionalized sulfonic acid-containing vinyl monomer, a functionalized/unfunctionalized phosphonic acid-containing vinyl monomer, and a combination thereof.

8. The hair styling polymer according to claim 1 wherein said olefinically-unsaturated acid monomer is selected from the group consisting of (meth)acrylic acid, styrenesulfonic acid, 2-acrylamido-2-methylpropane sulfonic acid, or a combination thereof.

9. The hair styling polymer according to claim 1 wherein said cross-linking agent is selected from divinyl ethers of an aliphatic diol of 1,2-ethanediol, 1,3-propanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 1,7-heptanediol, 1,8-octanediol, 1,9-nonanediol, 1,10-decanediol, 1,11-undecanediol, and 1,12-dodecanediol, or divinyl ethers of diethylene glycol of methylene glycol, tetraethylene glycol, pentaethylene glycol; hexaethylene glycol, heptaethylene glycol, octaethylene glycol, nonaethylene glycol, decaethylene glycol; or polyalkylene glycols and acrylates of polyethylene glycol diacrylate, trimethylolpropane triacrylate, propylene glycol diacrylate, polyhydric alcohols esterified once or twice with acrylic acid triallylamine, tetraallylethylenediamine, diallyl phthalate, pentaerythritol triallyl ether, pentaerythritol triacrylate, pentaerythritol tetraacrylate, N,N'-divinylimidazolidone, triallyl-1,3,5-triazine-2,4,6(IH,3H,5H)-trione and 2,4,6-triallyloxy-1,3,5-triazine.

10. The hair styling polymer derived from polymerizing:

(a) about 0.1 to 50% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety;

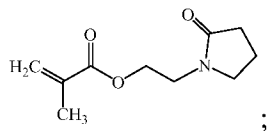
(b) about 5 to 80% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk) acrylates;

(c) about 1 to 50% by weight of at least one functionalized/ unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and

(d) about 0 to 5% by weight of at least one crosslinking agent.

11. The hair styling polymer derived from polymerizing:

(a) about 0.1 to 50% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety having the structure:



(b) about 10 to 75% by weight of methyl acrylate and/or butyl acrylate;

(c) about 1 to 50% by weight of methacrylic acid; and

(d) about 0 to 5% by weight of pentaerythritol triallyl ether (PETE).

12. A hair styling composition comprising:

(i) a hair styling polymer derived from polymerizing:

(a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety;

(b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates;

(c) about 0.1 to 99.9% by weight of at least one functionalized/ unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and

(d) 0 to 5% by weight of at least one crosslinking agent; and

(ii) one or more cosmetically acceptable additives.

13. The composition according to claim 12, wherein said additive is selected from the group consisting of auxiliary fixing agents, surfactants, preservatives, neutralizing agents, emulsion stabilizers, anti-static agents, fatty substances, gelling agents, thickeners, moisturizers, emollients, hydrophilic or lipophilic active agent, antioxidants, sequestering agents, fragrances, fillers, dyestuffs, emulsifying agents, solvents, UV-A or UV-B blocker/filters, plant extracts, proteins, peptides, silicones, personal care active ingredients and combinations thereof.

14. The composition according to claim 12, wherein the composition is formulated as clear gel, spray gel, cream gel, creams, emulsion, pomade, mousse, serum, styling lotion, styling wax, vesicle dispersion, paste, solid stick, shampoo or spray.

15. The composition according to claim 14, wherein the effective amount of composition used in the hair care composition is in the range of from about 0.01 wt. % to 5.0 wt. %.

16. A method for treating or fixing regular or damaged hair substrate comprising contacting said hair substrate with an effective amount of hair care composition of claim 12 comprising (i) a hair styling polymer of (a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety; (b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates; (c) about 0.1 to 99.9% by weight of at least one olefinically-unsaturated acid monomer or a salt thereof; and (d) 0 to 5% by weight of at least one crosslinking agent; and (ii) one or more of cosmetically acceptable additives.

17. A process for preparing a hair styling polymer comprising polymerizing:

(a) about 0.1 to 99.9% by weight of at least one monomer comprising at least one functionalized or unfunctionalized acryloyl moiety and at least one lactam moiety;

(b) about 0.1 to 99.9% by weight of at least one monomer selected from the group consisting of functionalized and unfunctionalized alkyl (alk)acrylates;

(c) about 0.1 to 99.9% by weight of at least one functionalized/unfunctionalized olefinically-unsaturated acid monomer or a salt thereof; and

(d) 0 to 5% by weight of at least one crosslinking agent.

18. The process according to claim 17, wherein the copolymer is prepared by radical polymerization, emulsion polymerization, ionic chain polymerization, bulk polymerization, suspension polymerization or precipitation polymerization.

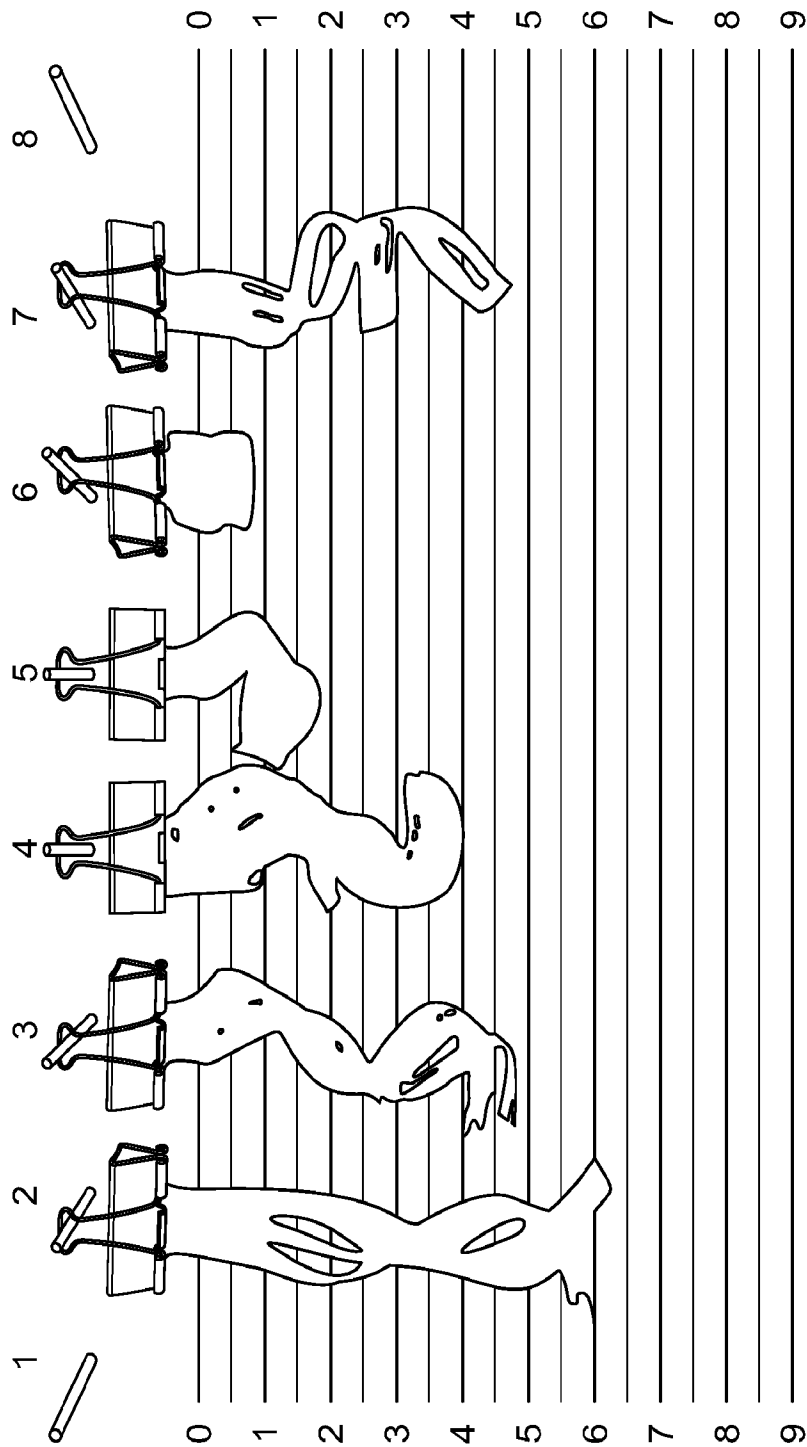


Figure 1

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2016/062403

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61K 8/81; A61K 5/06; C08F 220/18; C08F 226/10 (2016.01)

CPC - A61K 8/817; A61K 8/8182; A61Q 5/06; C08F 220/18; C08F 226/10; Y10S 424/01 (2016.11)

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)

IPC - A61K 8/81; A61Q 5/06; C08F 220/18; C08F 226/10

CPC - A61K 8/817; A61K 8/8182; A61Q 5/06; C08F 220/18; C08F 226/10; Y10S 424/01

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

USPC - 424/47; 424/70.150; 524/548; 526/264; IPC - A61K 8/81; A61Q 5/06; C08F 220/18; C08F 226/10;

CPC - A61K 8/817; A61K 8/8182; A61Q 5/06; C08F 220/18; C08F 226/10; Y10S 424/01 (keyword delimited)

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

Orbit, Google Patents, Google, PubChem, SureChem.

Search terms used: hair styling, terpolymer, acyloyl, lactam, (alk)acrylate

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------|-----------------------|
| Y         | US 4,767,613 A (NUBER et al) 30 August 1988 (30.08.1988) entire document           | 1, 6-10, 12-18        |
| Y         | US 5,730,966 A (TORGERSON et al) 24 March 1998 (24.03.1998) entire document        | 1, 6-10, 12-18        |
| A         | US 5,275,811 A (CHUANG et al) 04 January 1994 (04.01.1994) entire document         | 1-18                  |
| A         | US 4,859,460 A (MAHIEU et al) 22 August 1989 (22.08.1989) entire document          | 1-18                  |

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

23 December 2016

Date of mailing of the international search report

07 FEB 2017

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