(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 May 2014 (08.05.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/070192 A1

(51) International Patent Classification:
A61K 47/26 (2006.01) *C08F 120/56* (2006.01)
C08F 20/56 (2006.01) *C08F 220/56* (2006.01)

(21) International Application Number:
PCT/US2012/063211

(22) International Filing Date:
2 November 2012 (02.11.2012)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WO 2014/070192 A1

(54) Title: ACRYLAMIDE DERIVATIVES

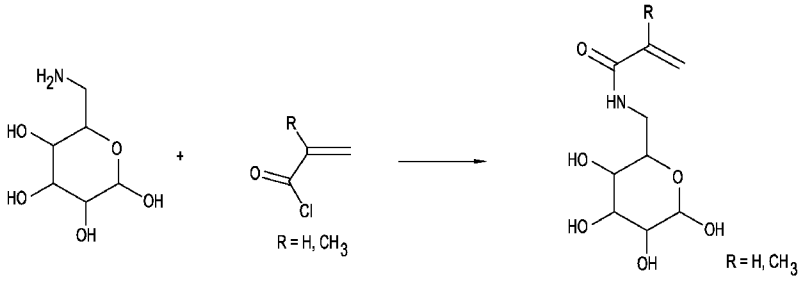


FIG. 3

(57) Abstract: Embodiments presented herein relate to acrylamide derivatives and uses thereof. Examples of such derivatives include acrylamide pyranose and other acrylamides that have other carbohydrate or 5 or 6 membered rings attached thereto. The compositions can be used for a variety of purposes, e.g., cosmetics, construction, scaffold materials, hydrogels, food additives, baby diapers, tubing sieves, etc.

ACRYLAMIDE DERIVATIVES

TECHNICAL FIELD

[0001] Embodiments provided herein generally relate to acrylamide derivatives.

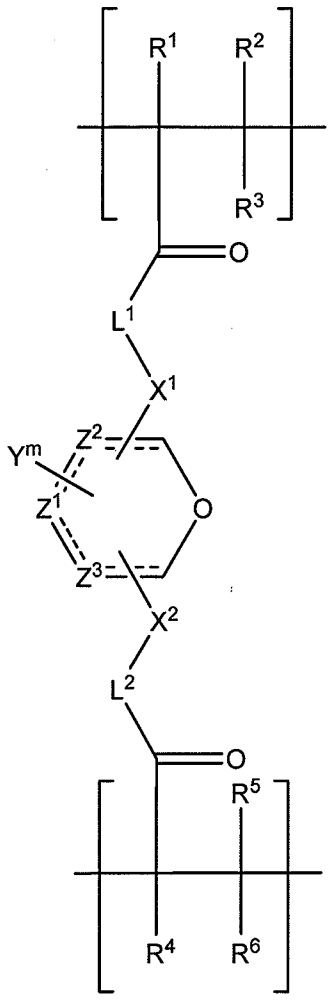
BACKGROUND

[0002] Acrylamide is a widely used chemical compound. It is derived from hydrating acrylonitrile. Its cousin methacrylamide is derived from acetone and hydrogen cyanide. The two vinyl amides are widely used across a number of industries ranging from agriculture, food, construction, adhesives, biotech, and medical.

SUMMARY

[0003] Provided herein are acrylamide derivatives, polymers thereof, and uses thereof.

[0004] In some embodiment, various compositions are provided. In some embodiments, the compositions can be cosmetic and can include a polymer and at least one cosmetic additive. The polymer can include one or more cross-linked monomer units. The cross-linked monomer units can be represented by Formula I:

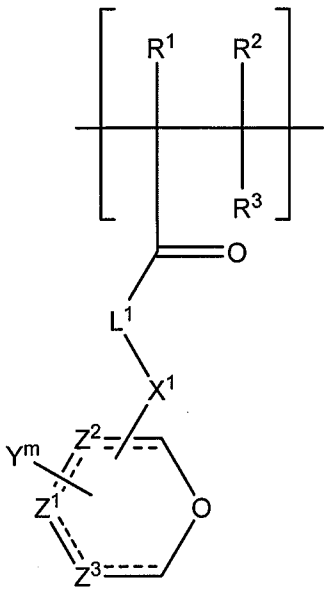


(I)

[0005] wherein, X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; L^2 is -NH-, S, or O; and each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, and C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18; Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of

Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; R^1, R^2, R^3, R^4, R^5, and R^6 are each optionally substituted and independently are hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl or C_2-C_{24} alkynyl, and each ------ is a double bond or a single bond.

[0006] In some embodiments, a cosmetic composition is provided. The composition can include a polymer and at least one cosmetic additive. The composition can include less than about 0.2% by weight of acrylamide monomer. The polymer can include a monomer unit represented by Formula VI:

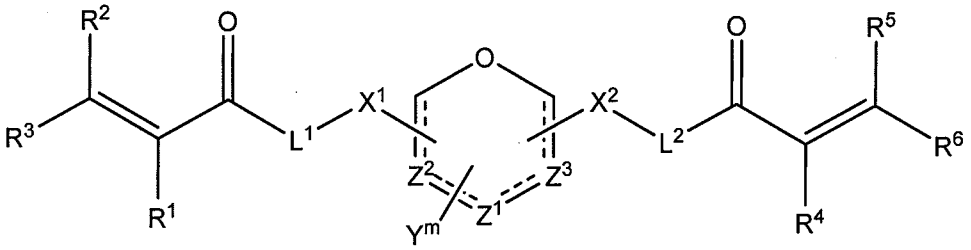


(VI)

[0007] wherein, X^1 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; and each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_x$, -$S(O)_xR^C$, -$OS(O)_x$, -$NS(O)_x$, -$NS(O)_xR^C$, -$P(O)_xR^C$, -$OP(O)_x$, -$NP(O)_x$, -$NP(O)_xR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each x is independently one, two, or three, and m is an integer from 0 to 19; Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is

optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1; R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl C_2-C_{24} alkynyl, or a substituted version thereof; and each ------ is a double bond or a single bond.

[0008] In some embodiments, a compound represented by Formula XI:

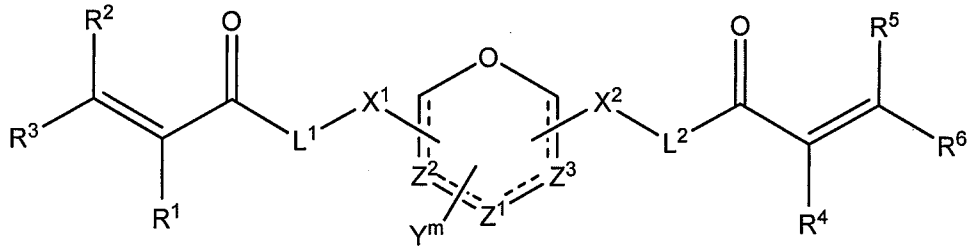


(XI)

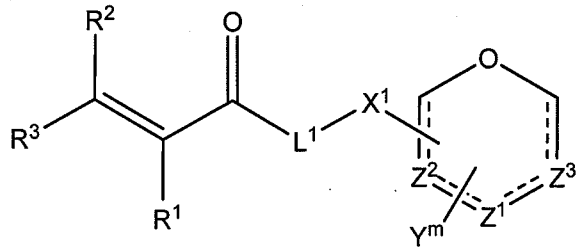
[0009] wherein, X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; L^2 is -NH-, S, or O; and each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer 0 to 18; Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and each ------ is a double bond or a single bond.

[0010] In some embodiments, a method of preparing a polymer is provided. In some embodiments, the method includes polymerizing one or more monomers to form a polymer. In some embodiments, the one or more monomers include a first monomer

selected from a monomer represented by Formula XIV, a monomer represented by Formula XV, and combinations thereof:



(XIV)

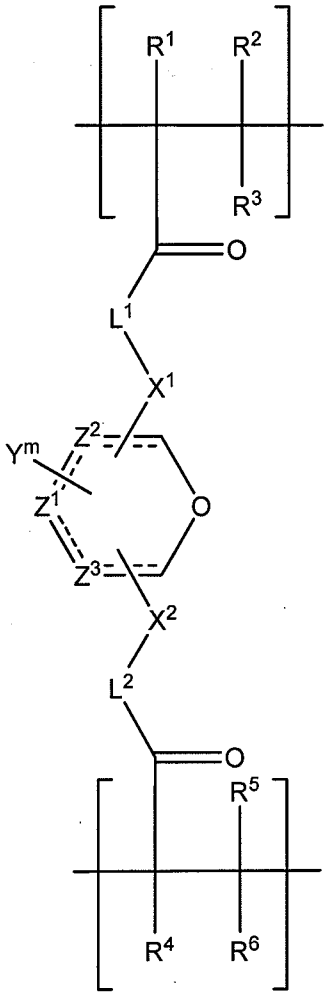


(XV)

[0011] wherein X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; L^2 is -NH-, S, or O; and each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18; Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; and R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and each ------ is a double bond or a single bond.

[0012] In some embodiments, a method of providing nutrients to skin is provided. In some embodiments, the method includes providing a cosmetic composition including a polymer; and applying the cosmetic composition to a subject's skin to

provide nutrients to the subject's skin. In some embodiments, the polymer includes one or more cross-linked monomer units, and the cross-linked monomer units are represented by Formula XX:

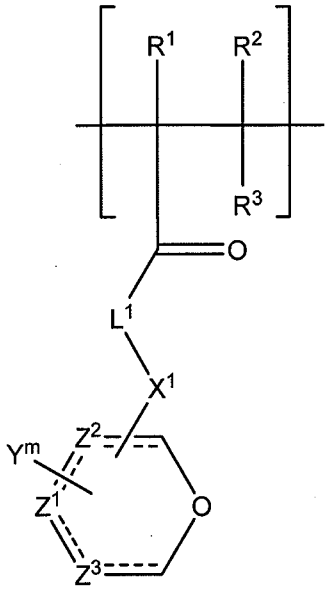


(XX)

[0013] wherein X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; L^2 is -NH-, S, or O; each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and n is an integer from 0 to 18. In some embodiments, Z^1, Z^2, and Z^3 are each independently a

single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and each ------ is a double bond or a single bond.

[0014] In some embodiments, a method of providing nutrients to skin is provided. In some embodiments, the method includes providing a cosmetic composition including a polymer, wherein the composition includes less than about 0.2% by weight of acrylamide, and applying the cosmetic composition to a subject's skin to provide one or more nutrients to the subject's skin. In some embodiments, the polymer includes one or more monomer units represented by Formula XXIII:

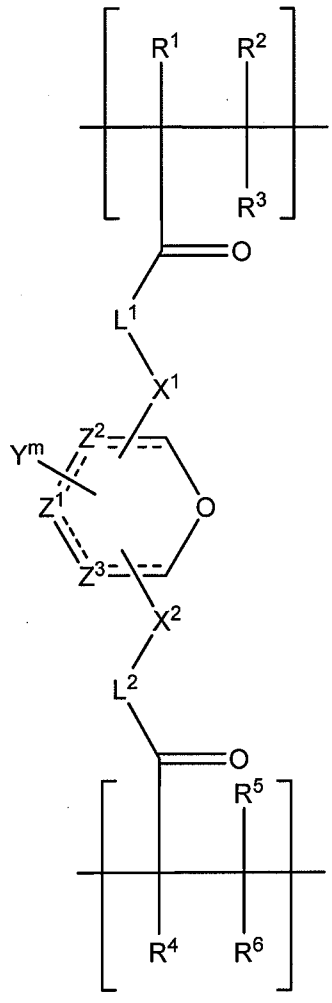


(XXIII)

[0015] wherein, X^1 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; and each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl,

unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and n is an integer from 0 to 19. In some embodiments, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2-; wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and each ------ is a double bond or a single bond.

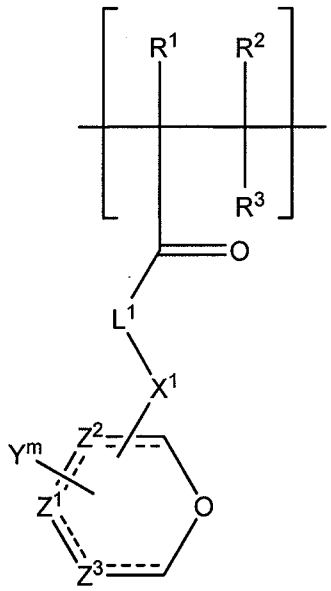
[0016] In some embodiments, a polymer including one or more cross-linked monomer units is provided. In some embodiments, the cross-linked monomer units are represented by Formula XXVI:



(XXVI)

[0017] wherein, X^1 is a bond or -C1-6 alkylene-; X^2 is a bond or -C1-6 alkylene-; L^1 is -NH-, S, or O; L^2 is -NH-, S, or O; and each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each RA and RB is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each RC is a bond, or -C_1-$_6$ alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18. In some embodiments, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Ym, and wherein each of Z1, Z^2, and Z3 is optionally substituted with X^1 or X^2. In some embodiments, R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and each ------ is a double bond or a single bond.

[0018] In some embodiments, a polymer is provided. In some embodiments, the polymer includes a monomer unit represented by Formula XXIX:



(XXIX)

[0019] wherein, X^1 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; and each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_x$, -$S(O)_xR^C$, -$OS(O)_x$, -$NS(O)_x$, -$NS(O)_xR^C$, -$P(O)_xR^C$, -$OP(O)_x$, -$NP(O)_x$, -$NP(O)_xR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each x is independently one, two, or three, and m is an integer from 0 to 19. In some embodiments, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1; R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and each ------ is a double bond or a single bond.

[0020] In some embodiments, a cosmetic composition is provided. In some embodiments, the composition includes at least one of a pyranose polyacrylamide polymer or a pyranose polymethacrylamide polymer and at least one cosmetic additive.

[0021] In some embodiments, a method of providing nutrients to skin is provided. In some embodiments, the method includes providing a cosmetic composition including a pyranose polyacrylamide polymer or a pyranose polymethacrylamide polymer; and at least one cosmetic additive. In some embodiments, the composition includes less than about 0.2% by weight of acrylamide. In some embodiments, the method further includes applying the cosmetic composition to a subject's skin to provide nutrients to the subject's skin.

[0022] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE FIGURES

[0023] **FIG. 1** is a depiction of the chemical structures of some embodiments of a mono (left) and bis (right) amino pyranose. Such moieties can be attached to acrylamide (or variants and/or polymers thereof).

[0024] **FIG. 2** is a depiction of the chemical structures of some embodiments of acrylamide (left) and poly(acrylamide) (right).

[0025] **FIG. 3** is a depiction of a reaction diagram for some embodiments of the structure and synthesis of N-(3,4,5,6-tetrahydroxy-tetrahydro-pyran-2-ylmethyl)-acrylamide.

[0026] **FIG. 4** is a reaction diagram for some embodiments of breakdown of polymers of acrylamide derivatives (in this case a pyranose derivative) into the products of adenosine-5'-triphosphate (ATP) and urea.

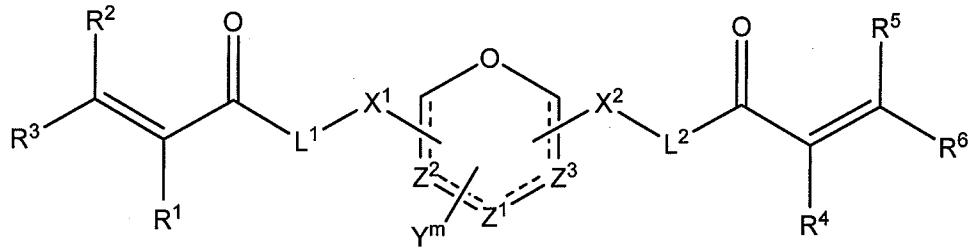
[0027] **FIG. 5** is a depiction of a reaction diagram for some embodiments of the structure and synthesis of 2-methyl-N-[3,4,6-trihydroxy-5-(2-methyl-acryloylamino)-tetrahydro-pyran-2-ylmethyl]-acrylamide.

DETAILED DESCRIPTION

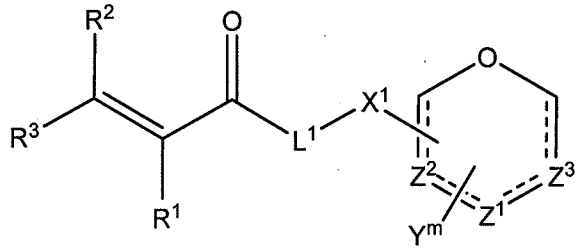
[0029] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

[0030] Provided herein are monomers, polymers, and compositions that generally relate to derivatives of acrylamide, including carbohydrate based derivatives of acrylamide.

[0031] Exemplary molecules that can serve as monomers and/or polymers include Formula XIV, and Formula XV, and combinations thereof:



(XIV)



(XV)

[0032] wherein R^1, R^2, R^3, L^1, X^1, Z^1, Z^2, Z^3, Y^m, X^2, L^2, R^4, R^5, and R^6 in Formula XIV can include those options provided in more detail below, and wherein R^1, R^2, R^3, L^1, X^1, Z^1, Z^2, Z^3, and Y^m can include those options provided in more detail below.

[0033] In some embodiments, the acrylamide derivative can have a carbohydrate and/or five or six membered ring attached to it, such as a pyranose moiety. In some embodiments, such arrangements can provide additional benefits and/or alternative properties over acrylamide, variants thereof, and/or polymers thereof.

[0034] In some embodiments, the degradation products from an acrylamide derivative are, or are similar to, adenosine triphospate (ATP) and/or urea, which are generally non-toxic and can readily be handled by humans and other organisms. In some embodiments, the acrylamide derivative can act as a cross-linker and allows for cross-linking of various polymers and/or other molecules. In some embodiments, even the cross-linker arrangements can also have degradation products that are also bio compatible. In some embodiments, one or more of any degradation products from the cross-linker can also be nontoxic (e.g., be, or be similar to, ATP and/or urea).

[0035] The present specification provides a brief definition section, followed by sections describing acrylamide derivatives, polymers thereof, methods of making and using, etc., followed by an examples section.

DEFINITIONS

[0036] As used herein, "alkyl" refers to a straight or branched hydrocarbon chain that includes a fully saturated (no double or triple bonds) hydrocarbon group. The alkyl group of the compounds may be designated as "C_1-C_4 alkyl" or similar designations. By way of example only, "C_1-C_4 alkyl" indicates that there are one to four carbon atoms in the alkyl chain, i.e., the alkyl chain is selected from methyl, ethyl, propyl, iso-propyl, n-butyl, iso-butyl, sec-butyl, and t-butyl. Typical alkyl groups include, but are in no way limited to, methyl, ethyl, propyl, isopropyl, butyl, isobutyl, tertiary butyl, pentyl, hexyl, and the like.

[0037] As used herein, "alkylene" refers to a straight or branched, fully saturated (no double or triple bonds) hydrocarbon tethering group that forms bonds to connect molecular fragments via their terminal carbon atoms. The alkylene group of the compounds may be designated as "-C_1-C_4 alkyl-" or similar designations. By way of example only, "-C_1-C_4 alkyl-" indicates that there are one to four carbon atoms in the alkylene chain. Examples of alkylene groups include but are not limited to methylene (-CH_2-), ethylene (-CH_2CH_2-), propylene (-$CH_2CH_2CH_2$-), dimethyl-methylene (-$CH(CH_3)_2$-), and butylene (-$CH_2CH_2CH_2CH_2$-).

[0038] As used herein, the term "hydroxyl" refers to a –OH group.

[0039] As used herein, "carboxyl" refers to "-C(=O)OH" group. As would be appreciated by the skilled artisan, a carboxyl group also includes its conjugate base.

[0040] As used herein, "substituted" refers to independent replacement of one, two, three, or more of the hydrogen atoms in the specified structure with a substituent. For example, methane substituted with one or more chlorines would include chloromethane, dichloromethane, trichloromethane, and carbon tetrachloride.

Acrylamide Derivatives

[0041] While a variety of acrylamide derivatives are disclosed herein, generally, the acrylamide derivative is one that includes a carbohydrate moiety. In some embodiments, any appropriate carbohydrate moiety can be used, including various 5 and/or 6 membered rings, such as various sugar moieties. **FIG. 1** depicts some embodiments of possible carbohydrate moieties that can be employed, *e.g.*, a root mono

and bis amino pyranose. Such compounds can be combined with acrylamide (**FIG. 2**, left), for example, as shown in **FIG. 3**, to produce an acrylamide derivative of acrylamide pyranose.

[0042] In some embodiments, the use of a carbohydrate, and/or sugar, and/or pyranose structure on an acrylamide molecule allows one to create a monomer and/or polymer product, whose natural breakdown product is, or is similar to, ATP and/or urea, natural, biological, products. For example, as shown in **FIG. 4,** which depicts a reaction scheme, in some embodiments, the acrylamide pyranose polymer, when broken down, results in ATP and urea, products which are not harmful (and can even be useful) for biological organisms. Thus, in some embodiments, the present compounds present an advantage over traditional acrylamide products, because the monomeric form of traditional acrylamide can be harmful, if not cancerous.

[0043] Furthermore, as noted above, in some embodiments, the acrylamide derivatives provide for a cross-linker. In some embodiments, this can be achieved by employing a carbohydrate with at least two amino groups on it (such as the bis amino pyranose structure shown on the right of **FIG. 1**) with the acrylamide. Because of the additional amino group, the carbohydrate can serve as a cross-linker between acrylamides and/or polyacrylamides (see, e.g., the right side of **FIG. 5**), thereby providing for a cross-linked structure of acrylamide and/or acrylamide polymer. In some embodiments, the cross-linked structure allows for the formation of a more rigid product. In some embodiments, the composition can be cross-linked to a level so as to provide a gel or gel-like composition of greater rigidity than a typical polyacrylamide gel. In some embodiments, the cross-linker can also have or provide a degradation product similar to that of the non-cross-linking embodiments, e.g., resulting in a non-toxic degradation product, such as ATP and urea and/or variations thereof.

[0044] Due to the mechanisms of action outlined for the acrylamide derivatives provided herein, one of skill in the art will appreciate that these derivatives can be formed for a variety of acrylamide variants (and polymers thereof), such as α-methylacrylamide, α-aethylacrylamide, α-cyanoacrylamide, maleic acid mono and bis sugar amide, itaconic acid mono and bis sugar amide, fumaric acid mono and bis amide. Furthermore, hydroxyl moieties can be functionalized with a variety of substituents such

as alkyl, ethers, and esters containing wide variety of functional moieties. Some non-limiting examples include 3-[(3,4,5,6-tetrahydroxy-tetrahydro-pyran-2-ylmethyl)-carbamoyl]-acrylic acid, but-2-enedioic acid bis-[(3,4,5,6-tetrahydroxy-tetrahydro-pyran-2-ylmethyl)-amide], 3-[(3,4,5,6-tetrahydroxy-tetrahydro-pyran-2-ylmethyl)-carbamoyl]-but-3-enoic acid, 2-methylene-N-(3,4,5,6-tetrahydroxy-tetrahydro-pyran-2-ylmethyl)-succinamic acid, N-(3,4,5-trihydroxy-6-methoxy-tetrahydro-pyran-2-ylmethyl)-(meth)acrylamide, 2-methyl-N-(3,4,5-trihydroxy-6-methoxy-tetrahydro-pyran-2-ylmethyl)-(meth)acrylamide, 2-methylene-N-(3,4,5-trihydroxy-6-methoxy-tetrahydro-pyran-2-ylmethyl)-succinamic acid, 3-[(3,4,5-trihydroxy-6-methoxy-tetrahydro-pyran-2-ylmethyl)-carbamoyl]-acrylic acid, N-(3,4-dihydroxy-5,6-dimethoxy-tetrahydro-pyran-2-ylmethyl)-(meth)acrylamide, N-(3-hydroxy-4,5,6-trimethoxy-tetrahydro-pyran-2-ylmethyl)-acrylamide, and N-(3,4,5,6-tetramethoxy-tetrahydro-pyran-2-ylmethyl)-acrylamide. In some embodiments, the amide moieties can be moved around the sugar ring.

[0045] In some embodiments, the present acrylamide derivatives (and/or polymers thereof) can be used as an alternative to methacrylate and other acrylics. In some embodiments, one difference between acrylamides and acrylates is that oxygen does not inhibit polymerization for the acrylamides while oxygen strongly inhibits polymerization of acrylates. In some embodiments, a difference between acrylamides from acrylates is that degradation products of acrylamide are much less acidic. Thus, in some embodiments, degradation of the acrylamide carbohydrate (such as an acrylamide sugar) allows for a product that has a degradation product that is less harmful than the degradation product for a traditional polyacrylamide.

[0046] In some embodiments, any carbohydrate moiety can be attached to the acrylamide (and/or polyacrylamide). In some embodiments, any sugar moiety can be attached to the acrylamide (and/or polyacrylamide).

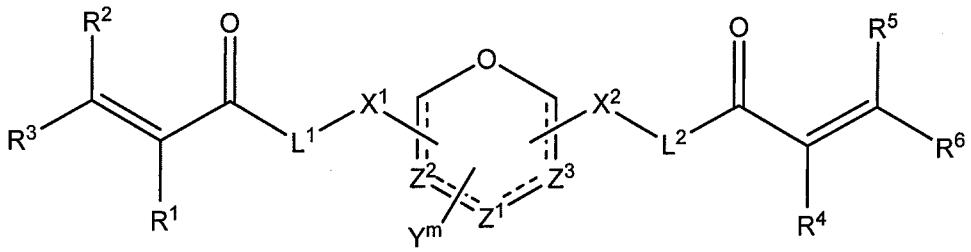
[0047] In some embodiments, when the acrylamide derivative has a sugar moiety attached to it, the sugar moiety is in a ring form (e.g., as shown in **FIG. 1**). In some embodiments, the sugar is in its linear form. Depiction of the ring form herein (including the claims) denotes the option of both the ring and linear form, unless otherwise specified. Thus, the depiction of the ring form is generic to both

configurations, unless otherwise specified. It is understood that any composition can, and under most scenarios will, include species in both of the structural arrangements.

[0048] In some embodiments, a 5 or 6 membered ring can be employed as the moiety for the acrylamide derivative. In some embodiments, any six-membered ring that has five carbons and one oxygen can be used. In some embodiments, the ring can include 1, 2, 3, or 4 –OH groups. In some embodiments, embodiments the ring can include 1, 2, 3, or 4 carboxylines, acetyl derivatives, sulfur, phosphors, nitrogen, ester, ketones, and/or ethers. In some embodiments, the sugar can be a decose, heptose, pentose, aldose, tetrose, glucose, galactose, fructose, and/or manose. In some embodiments, the oxygen in the ring (e.g., **FIG. 3**) can be substituted with a sulfur. In some embodiments, the nitrogen in the structure (**FIG. 3**) can be substituted with a sulfur. In some embodiments, a sulfur can be substituted at positions 2, 3, 4, 5, 6 of the molecule shown in the right side of **FIG. 3**. In some embodiments, any one or combination of the above can be made to any of the molecules provided herein.

[0049] While there are a wide variety of possible carbohydrates that can be attached to acrylamide to produce the acrylamide derivative, as noted above, in some embodiments, the acrylamide derivative includes two or more amino, oxygen, and/or sulfur groups, so that the acrylamide derivative can function as a cross-linker. In some embodiments, more than two amino groups can be employed. In some embodiments, tri(meth)acrylamides and/or tetra(meth)acrylamides can be employed. Some examples include N-(5,6-bis-(meth)acryloylamino-3,4-dihydroxy-tetrahydro-pyran-2-ylmethyl)-(meth)acrylamide, N-(4,5,6-tris-(meth)acryloylamino-3-hydroxy-tetrahydro-pyran-2-ylmethyl)-(meth)acrylamide, and N-(3,4,5,6-tetrakis-(meth)acryloylamino-tetrahydro-pyran-2-ylmethyl)-(meth)acrylamide

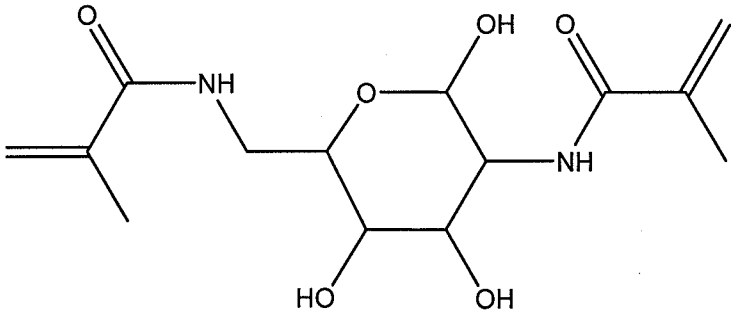
[0050] In some embodiments, the acrylamide derivative cross-linker is represented by Formula XI:



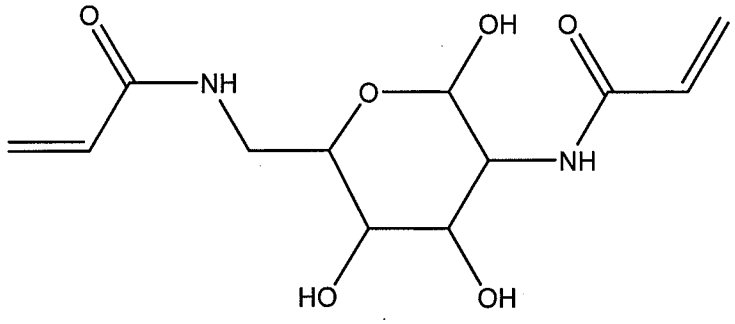
(XI)

[0051] wherein, X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; and L^2 is -NH-, S, or O. In some embodiments, each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer 0 to 18; wherein, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; wherein, R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and wherein each ------ is a double bond or a single bond.

[0052] In some embodiments, the acrylamide derivative is one that is represented by Formulae XII or XIII:



(XII)



(XIII)

[0053] In some embodiments, these compounds are separate from any polymer product. In some embodiments, these molecules are monomers within a polymer. In some embodiments, these compounds are in mixtures which also include polymers and/or other monomers.

Polymers

[0054] In some embodiments, one or more of the monomers of the acrylamide derivative provided herein can be used in or to create a polymer. In some embodiments, the polymers can provide one or more of the following advantages: non-carcinogenic, lower viscosity solutions, used at high concentrations, toxic materials are not released, degradation products of acrylamides are much less acidic, elimination of inflammatory response, strong affinity for water, superior moisturizer, environmentally friendly and biodegradable, oxygen does not inhibit polymerization, and/or provides an energy source for cell growth and skin health, when compared to traditional acrylamides.

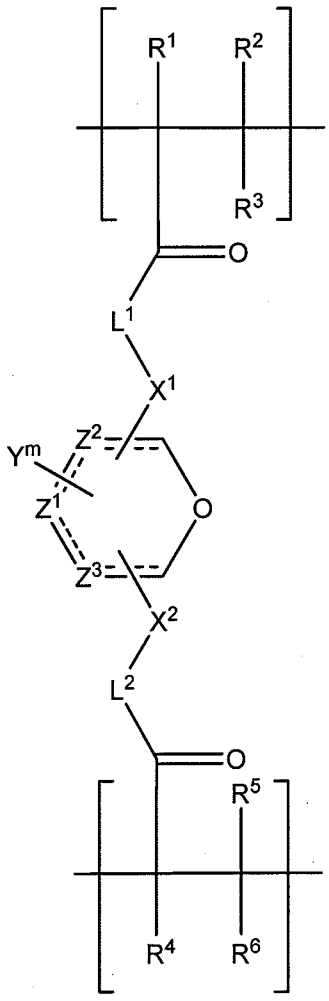
[0055] In some embodiments, any of the molecules provided herein can be used as monomer in a polymer.

[0056] In some embodiments, the polymers provided herein can be used as an alternative and/or as a supplement to a polyacrylamide polymer. For example, a polyacrylamide derivative can be used as an additive to cosmetics (e.g., as a hydrogel material) to moisturize the skin and give a better feel of the product to the consumer. Similarly, they can be used as a water absorbent polymer, capable to absorbing up to 1000 times it weight in distilled water, and 50 times it weight in 3% saline solution. In some embodiments, the acrylamide derivative will be a better water absorbent in saline.

[0057] In some embodiments, temperatures of 120 degrees Centigrade need not be employed when using the acrylamide derivative.

[0058] In some embodiments, the polymer can include any one or more of the compounds provided herein. In some embodiments, the polymer can include any one or more of the monomer units provided below.

[0059] In some embodiments, the polymer includes one or more cross-linked monomer units, wherein the cross-linked monomer units are represented by Formula XXVI:

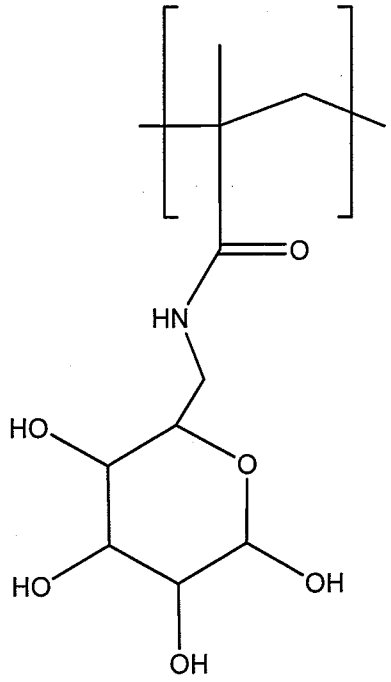


(XXVI)

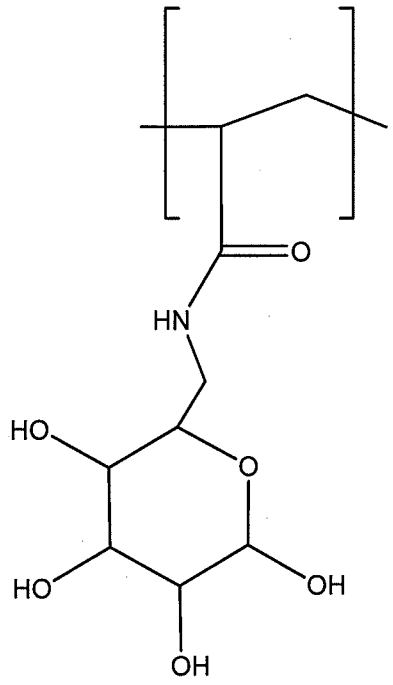
[0060] wherein, X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; and L^2 is -NH-, S, or O. In some embodiments, each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18; wherein, Z^1, Z^2, and Z^3 are each independently a single

bond, a double bond, $-CH_2-$, $-CH(OH)-$, $-CH=$, $-CH_2-CH_2-$, $=CH-CH_2-$, $=CH-CH=$, $-CH=CH-$, $-CH_2-CH_2-CH_2-$, $=CH-CH_2-CH_2-$, $=CH-CH_2-CH=$, $=CH-CH=CH-$, or $-CH=CH_2-CH_2-$ wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; wherein R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and wherein each ------ is a double bond or a single bond.

[0061] In some embodiments, the polymer does not need to include a cross-linked monomer. In some embodiments, the polymer includes a monomer unit represented by Formulae XXVII or XXVIII:

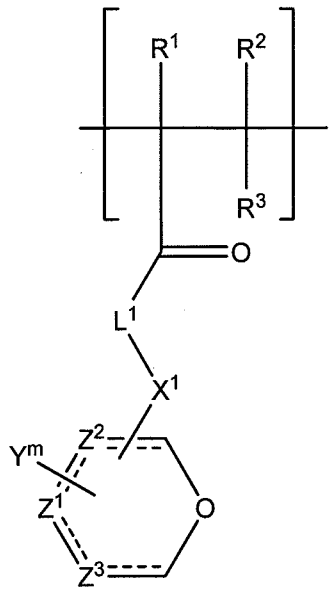


(XXVII)



(XXVIII).

[0062] In some embodiments, a polymer including a monomer unit represented by Formula XXIX:

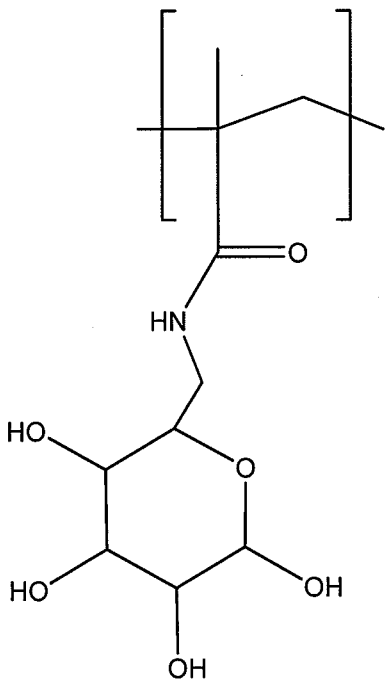


(XXIX)

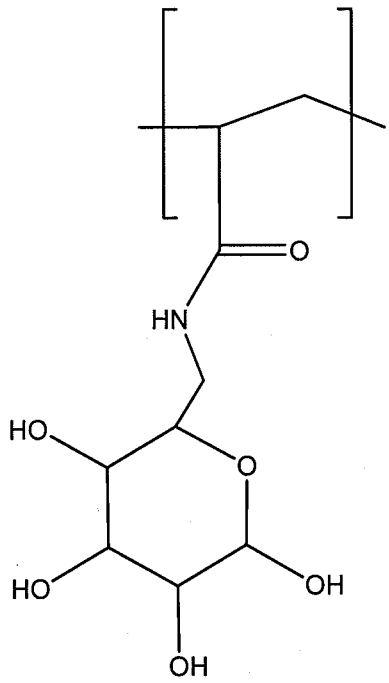
[0063] wherein, X^1 is a bond or -C_{1-6} alkylene-; and L^1 is -NH-, S, or O. In some embodiments, each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_x$, -$S(O)_xR^C$, -

$OS(O)_x$, $-NS(O)_x$, $-NS(O)_xR^C$, $-P(O)_xR^C$, $-OP(O)_x$, $-NP(O)_x$, $-NP(O)_xR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or $-C_{1-6}$ alkylene-, wherein each x is independently one, two, or three, and m is an integer from 0 to 19; wherein, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, $-CH_2-$, -CH(OH)-, -CH=, $-CH_2-CH_2-$, =CH-CH_2-, =CH-CH=, -CH=CH-, $-CH_2-CH_2-CH_2-$, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1; wherein, R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof, and wherein each ------ is a double bond or a single bond.

[0064] In some embodiments, the polymer includes a monomer unit represented by Formula XXX or XXXI:



(XXX)



(XXXI)

[0065] In some embodiments, the acrylamide derivative can be used in foods, cosmetics, construction, and/or adhesives. In some embodiments, the acrylamide derivative can be used to reduce an amount of a non-derivative acrylamide to under an average of 0.03% of a composition by weight, e.g., less than 0.02, 0.01, 0.001, or 0.0001%. In some embodiments, the acrylamide derivative can be used to reduce non-derivative acrylamide (e.g., the acrylamide shown in FIG. 2) levels in a product to 5 ppm

acrylamide residues or less, for example, in cosmetics and personal care products, e.g., less than 5, 4, 3, 2, 1, 0.5, 0.1, 0.05, 0.01, 0.001, 0.0001, 0.00001, 0.000001 or less ppm.

[0066] In some embodiments, the polymer can be any size. In some embodiments, the polymer can include 2 or more monomers. In some embodiments, the polymer is about 10,000 to about 1,000,000 units in size, e.g., 10,000, 50,000, 100,000, 200,000, 300,000, 400,000, 500,000, 600,000, 700,000, 800,000, 900,000, or 1,000,000 units in size, including any range above any one of the preceding values and any range between any two of the preceding values.

Cosmetic Composition

[0067] In some embodiments, the monomers, polymers, and decomposition products provided herein can be used or be present in cosmetics and/or personal care products. In some embodiments, any acrylamide derivative can be used in the formulation of one or more product types including skin cleansers, moisturizers, lotions and creams, self tanning products, makeup, hair care and nail care products. In some embodiments, the acrylamide derivative can be used to replace and/or supplement traditional poly(acrylamide). In some embodiments, the resulting cosmetic product has less than about 0.2% acrylamide monomer in it, e.g., 0.19, 0.15, 0.1, 0.05, 0.01, 0.001, 0.0001, 0.00001% or lower of an amount of acryalmide monomer present. In some embodiments, there is no acryalamide monomer, or at least no more than is detectable.

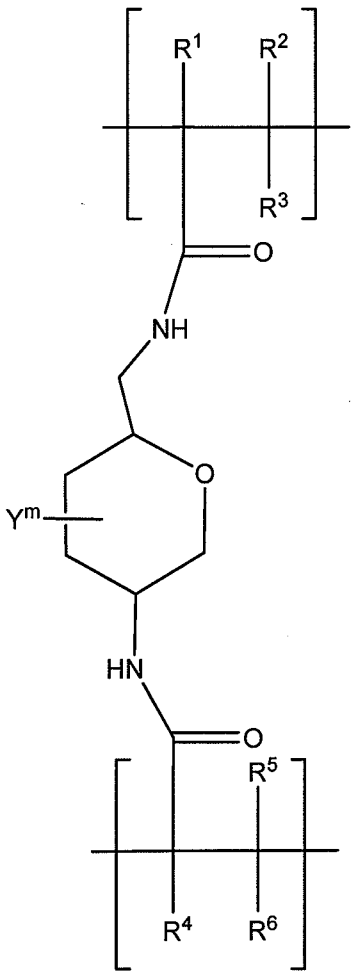
[0068] In some embodiments, the acrylamide derivative can be used in body-care leave-on products and other cosmetic products. In some embodiments, the product will have a maximum residual acrylamide content of less than about 0.5 mg/kg, e.g., 0.4, 0.3, 0.2, 0.1, 0.05, 0.01, 0.005, 0.001, 0.0001, 0.00001 or lower, including any range between any two of the preceding values and any range beneath any one of the preceding values.

[0069] In some embodiments, the acrylamide derivative, in polymer form, exhibits excellent utility in cosmetics to make the product appear more pleasing, palatable, and attractive to the user and/or customer. In some embodiments, the product having the polymer does not have the carcinogenic affects of acrylamide due to differences in structure and behavior upon degradation.

[0070] In some embodiments, a cosmetic composition is provided and can include a pyranose polyacrylamide polymer and/or a pyranose polymethacrylamide polymer. In some embodiments, it can further include at least one cosmetic additive.

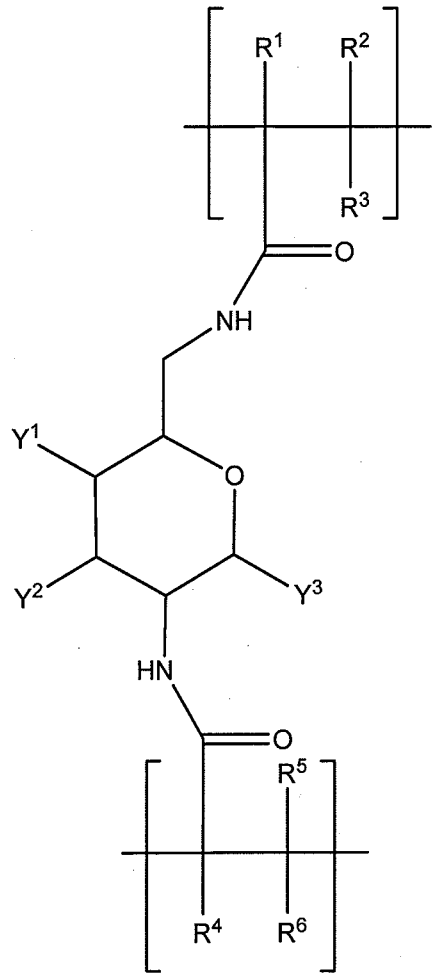
[0071] In some embodiments, the cosmetic composition includes a polymer and at least one cosmetic additive. In some embodiments, the polymer includes any one or more of the cross-linked monomer units, provided herein.

[0072] In some embodiments, the cosmetic composition can include the compound of Formula I. In some embodiments, Z^1 is $-CH_2-$, $-CHY^m-$, or $-CY^mY^m-$. In some embodiments, Z^2 is $-CH_2-$, $-CHY^m-$, or $-CY^mY^m-$. In some embodiments, Z^3 is $-CH_2-$, $-CHY^m-$, $-CY^mY^m-$, or $-CHX^2-$. In some embodiments, Z^3 is $-CHX^2-$. In some embodiments, Z^1, Z^2, and Z^3 are each $-CH(OH)-$. In some embodiments, L^1 is -NH-. In some embodiments, L^2 is -NH-. In some embodiments, each ------ is a single bond. In some embodiments, the molecule can be that depicted in Formula II:



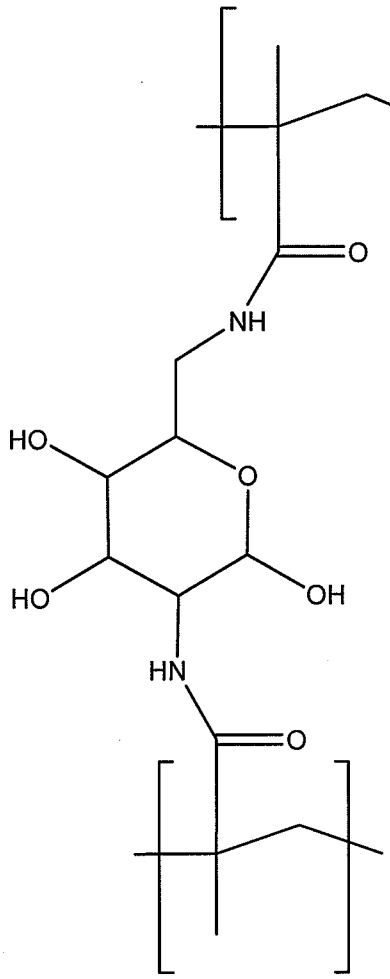
(II)

[0073] In some embodiments, the cosmetic composition can include the cross-linked monomer units represented by Formula III:

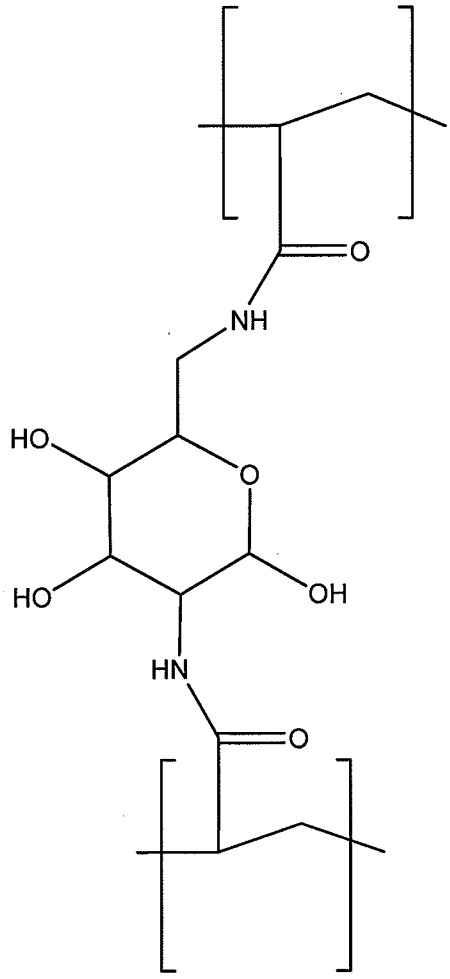


(III)

[0074] wherein Y^1, Y^2, and Y^3 are each independently Y^m; wherein Y^1, Y^2, and Y^3 are each hydroxyl, wherein R^1 is hydrogen or methyl, wherein, R^4 is hydrogen or methyl; wherein R^1 is methyl, R^4 is methyl, R^3 is hydrogen, and R^6 is hydrogen; and wherein R^2, R^3, R^5, and R^6 are each hydrogen. In some embodiments, the cross-linked monomer units are represented by Formula IV or V:

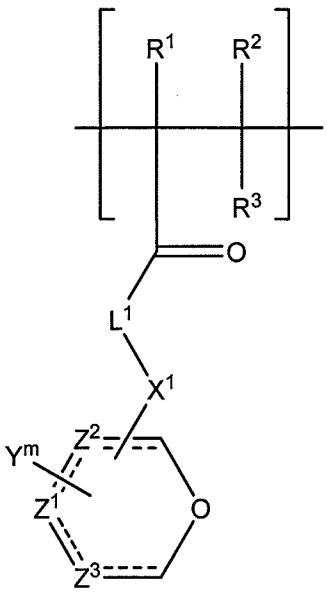


(IV)



(V)

[0075] In some embodiments, the cosmetic composition need not be cross-linked or include a second nitrogen group for cross-linking. In some embodiments, the cosmetic composition can include less than about 0.2% by weight of an acrylamide monomer. In some embodiments, the polymer can include a monomer unit represented by Formula VI:

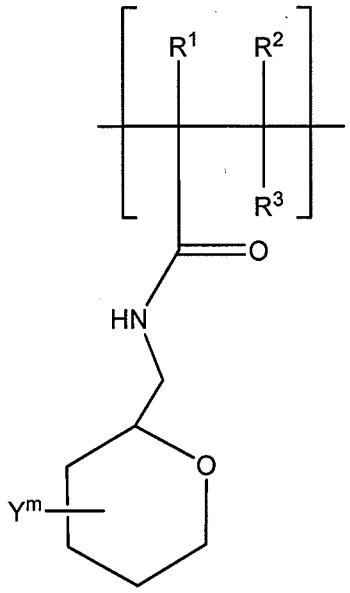


(VI)

[0076] wherein X^1 is a bond or -C_{1-6} alkylene-; and L^1 is -NH-, S, or O. In some embodiments, each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_x$, -$S(O)_xR^C$, -$OS(O)_x$, -$NS(O)_x$, -$NS(O)_xR^C$, -$P(O)_xR^C$, -$OP(O)_x$, -$NP(O)_x$, -$NP(O)_xR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each x is independently one, two, or three, and m is an integer from 0 to 19. In some embodiments, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1; wherein R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl C_2-C_{24} alkynyl, or a substituted version thereof; and wherein each ------ is a double bond or a single bond.

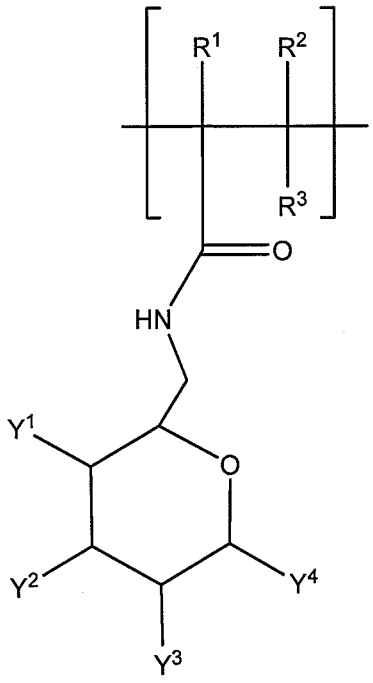
[0077] In some embodiments, Z^1 is -CH_2-, -CHY^m-, or –CY^mY^m-. In some embodiments, Z^2 is -CH_2-, -CHY^m-, or –CY^mY^m-. In some embodiments, Z^3 is -CH_2-, -CHY^m-, –CY^mY^m-, or –CHX^2-. In some embodiments, Z^3 is –CX^2-. In some embodiments, Z^1, Z^2, and Z^3 are each –CH(OH)-. In some embodiments, L^1 is -NH-. In

some embodiments, L^2 is -NH-. In some embodiments, each ------ is a single bond. In some embodiments, the monomer unit is represented by Formula VII:



(VII).

wherein Y^1, Y^2, Y^3, and Y^4 are each independently Y^m. In some embodiments, the monomer unit is represented by Formula VIII:

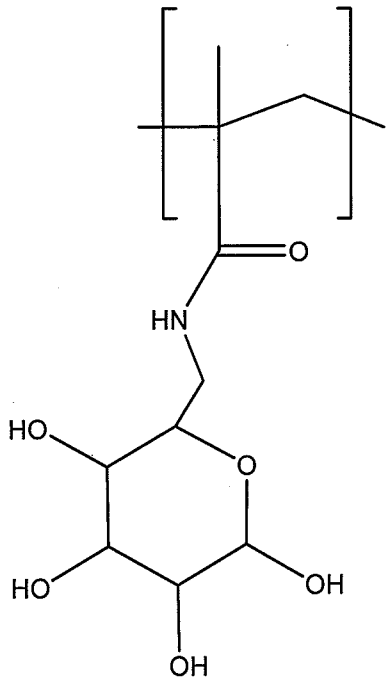


(VIII)

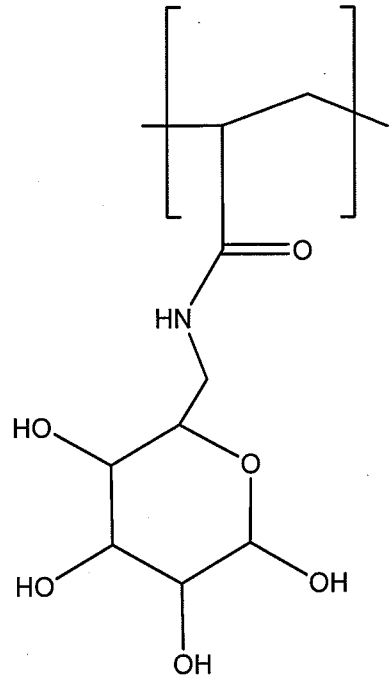
[0078] wherein Y^1, Y^2, Y^3, and Y^4 are each independently Y^m. In some embodiments, Y^1, Y^2, Y^3, and Y^4 are each hydroxy. In some embodiments, R^1 is hydrogen or methyl. In some embodiments, R^2 is hydrogen R^3 is hydrogen.

[0079] In some embodiments, the cosmetic composition includes less than about 1% by weight of acrylamide and methacrylamide monomer units, e.g., less than 0.9, 0.5, 0.1, 0.01, 0.001, 0.0001, 0.00001, 0.000001, or 0.0000001% by weight, including any range between any two of the preceding values and any range beneath any single value (including no detectable amount of acyrlamide and/or methacrylamide).

[0080] In some embodiments, the cosmetic composition can include a polymer including a monomer unit represented by Formula IX or X:



(IX)



(X)

[0081] In some embodiments, any of a variety of cosmetic additives or ingredients can be combined with any one or more of the polymers provided herein. In some embodiments, the cosmetic additive can be a GRAS ingredient ("Generally Regarded as Safe"). In some embodiments, the cosmetic additive can include one or more of the following: denatured alcohol, alkyl benzoate C_{12}-C_{15}, allantoin, alpha-isomethyl ionone, aluminum chlorohydrate, water, wax, ascorbyl plamitate, butane, butyrospermum parkii, hydroxyethyl-cellulose, hydroxypropyl-cellulose, isobutane, isopentane, propane, sodium hydroxide, castor oil, dye, triethanolamine, purified water, sodium lauryl sulfate (from coconut oil), sodium laureth sulfate (from coconut oil), olefin sulfonate, cocamidopropyl betaine (from coconut oil), decyl glucoside, citric acid, paraben, emulsifying wax, beeswax, vegetable glycerin, oat bran, passion fruit juice, red rose water, raspberry extract, yucca herbal extract, aloe vera leaf gel, tea tree oil,

peppermint leaf oil, spearmint leaf oil, wintergreen leaf oil, lavender oil, cinnamon leaf oil, lemon Peel oil, valencia orange peel oil, pink grapefruit peel oil, roman chamomile oil, jasmine oil, extra virgin olive oil, saponified oil of coconut, saponified oil of palm, hemp seed oil, jojoba seed oil, or sunflower oil. In some embodiments, the cosmetic can include at least one of titanium dioxide white; one or more of the following iron oxides: black oxide, brown oxide, orange oxide, red oxide (red shade), red oxide (blue shade), yellow oxide; chromium oxide green; hydrated chromium oxide green; pluot purple; ultramarine blue; ultramarine violet; and ultramarine pink

[0082] In some embodiments, the cosmetic need not be limited to any particular type of cosmetic. In some embodiments, the cosmetic can be, for example, a facial cosmetic, a lotion, a cream, e.g., an antiwrinkle cream, a sunscreen, a foundation, a lipstick, a gloss, a perfume, a deodorant, hair spray, shampoo, shaving cream, mascara, and/or an antiperspirant.

[0083] In some embodiments, the polymers and/or monomers of the acrylamide derivatives can be used in applications and compositions other than cosmetics. In some embodiments, the compounds can be used in cell growth media, as a scaffold material, in a hydrogel, as a food additive, in baby diapers, in organ manufacture, in tissue engineering, in tubing sieves, and/or in construction.

Method of Preparing

[0084] There are a variety of ways in which the various embodiments can be made. In some embodiments, the acrylamide derivatives can be made by the coupling reaction between an amine and an acid chloride. In some embodiments, the amine is on the carbohydrate unit (e.g., a pyranose unit) and is usually protected as the hydrochloride. In some embodiments, the acid chloride is a polymerizable functional unit such as acrylchoride. In some embodiments, there is no need to protect the hydroxyl units on the carbohydrate (e.g., pyran ring) as the amino moieties are much more reactive than hydroxyl moieties and as such couple with the amino exclusively

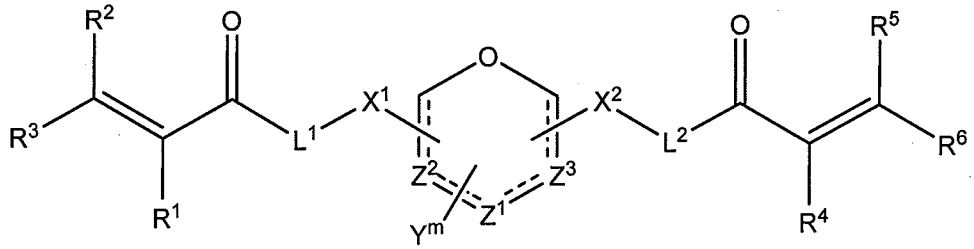
[0085] **FIG. 3** depicts some embodiments for the synthesis of an acrylamide pyranose unit. Additional method of making various acrylamide pyranose units are outlined in Examples 1-4. For the bis amino structures, **FIG. 5** depicts some

embodiments of how some such molecules can be made and various further Examples are provided in Examples 5-7.

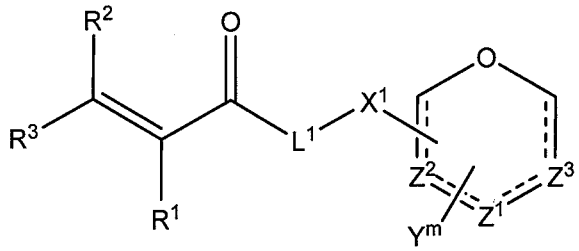
Method Of Polymerizing

[0086] There are a variety of approaches to polymerizing one or more of the various monomers provided herein into a polymer.

[0087] In some embodiments, a method of preparing a polymer is provided. In some embodiments the method includes polymerizing one or more monomers to form a polymer. In some embodiments, the one or more monomers include a first monomer selected from the group of a monomer represented by Formula XIV, a monomer represented by Formula XV, and combinations thereof:



(XIV)



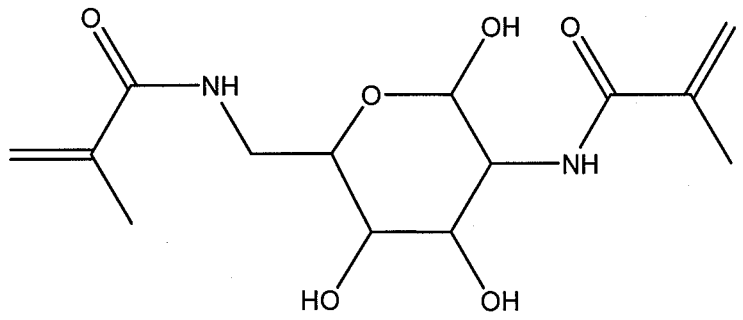
(XV)

[0088] wherein, X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; L^1 is -NH-, S, or O; and L^2 is -NH-, S, or O; wherein, each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18; wherein Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -

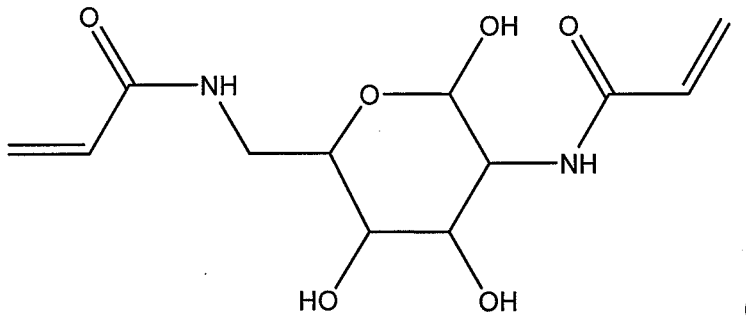
CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; wherein R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and wherein each ------ is a double bond or a single bond.

[0089] In some embodiments, the one or more monomers do not include methacrylamide or acrylamide. In some embodiments, the amount of methacrylamide or acrylamide is so low as to be undetectable. In some embodiments, any amount of included methacrylamide or acrylamide is so low as to not contribute, structurally, to the formation of the polymer.

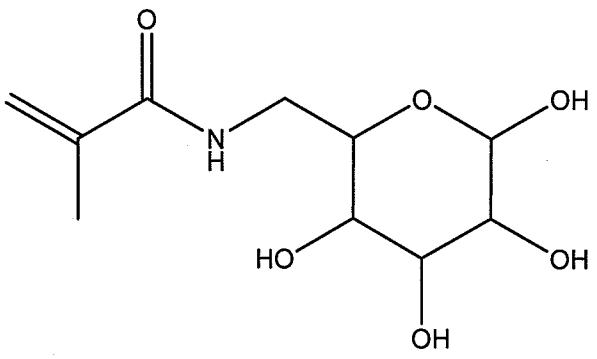
[0090] In some embodiments, the one or more monomers are represented by Formula XVI, XVII, XVIII or XIX:



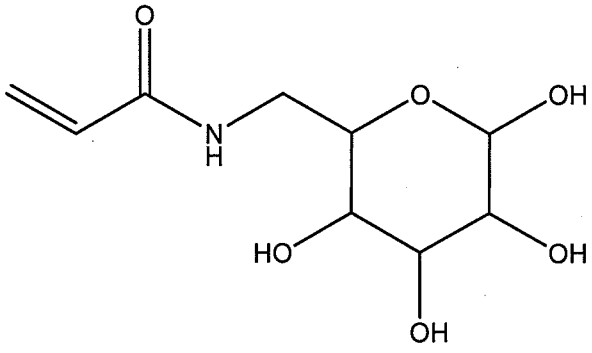
(XVI)



(XVII)



(XVIII)



(XIX).

[0091] In some embodiments, there are a wide variety of polymerization techniques that are applicable and allow for tuning the acrylamide derivative. In some embodiments, polymerization is driven by a polymerization catalyst. In some embodiments, polymerization is achieved by UV exposure. In some embodiments, the acrylamide can be polymerized by free radicals. The radicals can be generated by thermal, photochemical, electrochemical, and/or redox means. However, some derivatives of the acrylamide can also be polymerized by anionic polymerization.

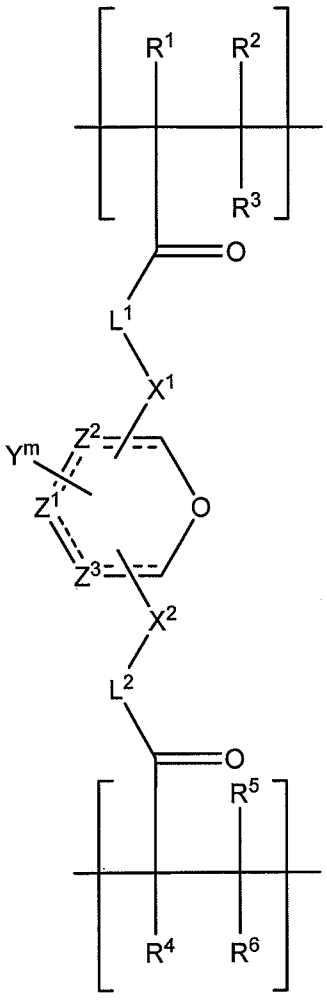
Nutrients To Skin

[0092] In some embodiments, the one or more of the monomers and/or polymers provided herein can be employed to provide nutrients to skin. In some embodiments, this can be achieved via the pathway depicted in **FIG. 4** (e.g., allowing the breakdown of an acrylamide derivative into adenosine triphosphate and/or urea. In some embodiments, this can be achieved by the amount of water that can be present with the monomer and/or polymer of the acrylamide derivative.

[0093] In some embodiments, one or more of the sugar based acrylamide can be used to provide one or more nutrients to the skin. In some embodiments, the method includes providing a cosmetic composition that includes a polyacrylamide derivative,

such as a pyranose polyacrylamide polymer or a pyranose polymethacrylamide polymer . In some embodiments, the composition can also include at least one cosmetic additive. In some embodiments, the composition includes less than about 0.2% by weight of acrylamide (including other ranges provided herein). In some embodiments, the method further includes applying the cosmetic composition to a subject's skin to provide nutrients to the subject's skin. In some embodiments, any, and any combination, of acrylamide derivatives (monomers and/or polymers) provided herein can be used to provide nutrients to the skin or to a subject.

[0094] In some embodiments, a method of providing nutrients to the skin is provided. In some embodiments, the method includes providing a cosmetic composition including a polymer (e.g., any of the polymers, or combinations thereof provided herein) and applying the cosmetic composition to a subject's skin to provide nutrients to the subject's skin. In some embodiments, the polymer includes one or more cross-linked monomer units, and wherein the cross-linked monomer units are represented by Formula XX:

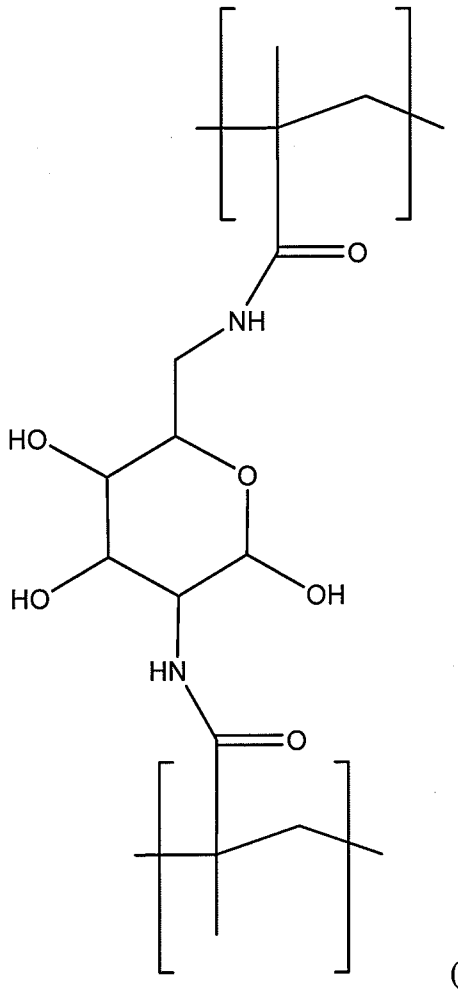


(XX)

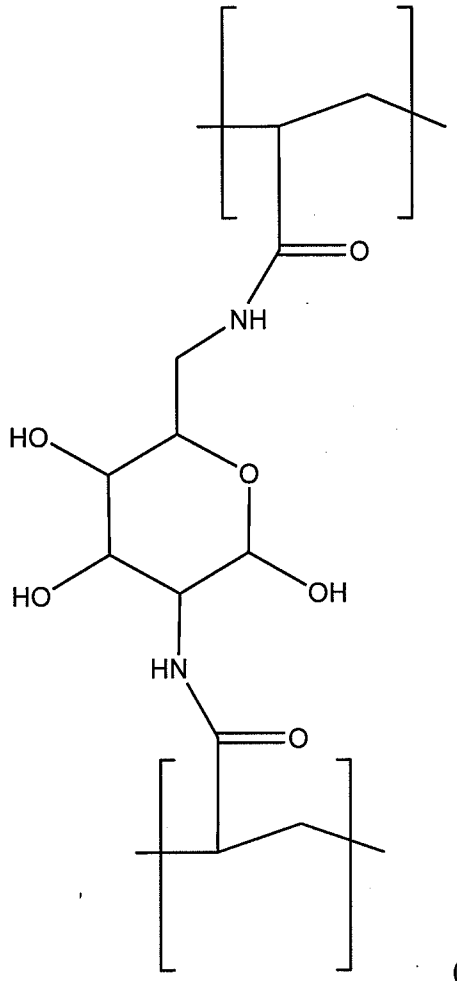
[0095] wherein, X^1 is a bond or -C_{1-6} alkylene-; X^2 is a bond or -C_{1-6} alkylene-; and L^1 is -NH-, S, or O; L^2 is -NH-, S, or O; wherein each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and n is an integer from 0 to 18. In some embodiments, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one,

two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; wherein, R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and wherein each ═══ is a double bond or a single bond.

[0096] In some embodiments, the polymer added can be that represented by Formula XXI or XXII:

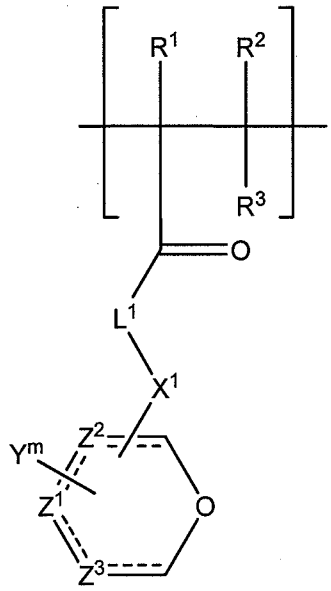


(XXI)



(XXII)

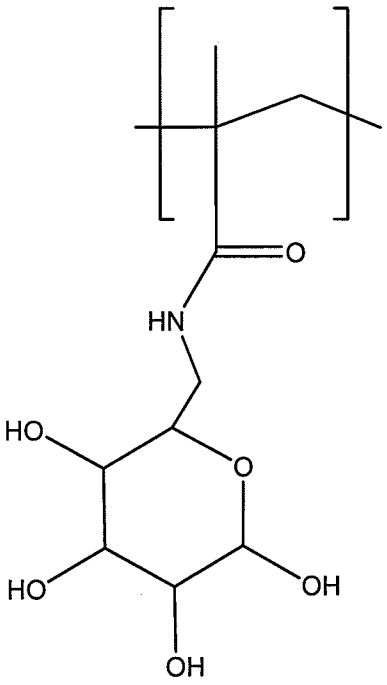
[0097] In some embodiments, the polymer includes one or more monomer units represented by Formula XXIII:



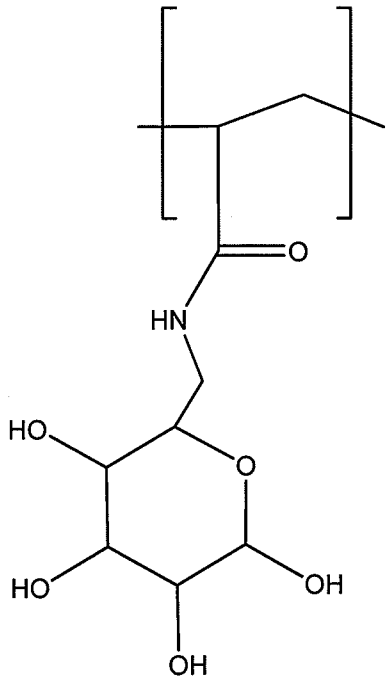
(XXIII)

[0098] wherein, X^1 is a bond or -C_{1-6} alkylene-; and L^1 is -NH-, S, or O; wherein each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and n is an integer from 0 to 19; wherein, Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2; wherein R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof and wherein each ------ is a double bond or a single bond.

[0099] In some embodiments, the polymer that can be used is represented by Formula XXIV or XXV:



XXIV



XXV

[0100] The type of skin that the nutrients are applied to can be any of a variety of types, including skin that is also in contact with cosmetics. In some embodiments, the skin is the skin of a subject's face. In some embodiments, the skin can be around the nose, mouth, eyes, and/or ears. In some embodiments, the skin can include leg, arm, back, etc. In some embodiments, the skin is human. In some embodiments, the skin is another animal's skin, such as pets, food source animals, and/or farm animals. In some embodiments, one or more of the derivatives provided herein have a lower risk and/or likelihood of inducing allergies to a subject who is allergic to traditional forms of polyacrylamide.

EXAMPLES

EXAMPLE 1

SYNTHESIS OF N-(3,4,5,6-TETRAHYDROXY-TETRAHYDRO-PYRAN-2-YLMETHYL)-ACRYLAMIDE

[0102] N-(6-deoxy-D-galactose)-acrylamide is synthesized by means of acid chloride coupling mediated by an organic base. Anhydrous THF (500 mL) is added to a

flame dried 1L three neck flask and flooded with argon. To the THF is added 30.0 g (139.5 mmol) of anhydrous 6-amino-6-deoxy-D-galactose hydrochloride and 15.6 g (197.2 mmol) anhydrous pyridine and allowed to dissolve at a temperature of -20 degrees Centigrade. Then, by drop wise addition, 13.1 g (140.5 mmol) of acrylchloride in 50 mL of dry THF is added to the 6-amino-6-deoxy-D-galactose solution at room temperature followed by warming to 25 degrees Centigrade. The reaction is allowed to proceed for five hours at 25 degrees Centigrade. The pyridinium chloride is then removed by filtration followed by washing and the solvents removed by rotary evaporation and high vacuum to yield N-(6-deoxy-D-galactose)-acrylamide. The general reaction scheme is shown in **FIG. 3**.

EXAMPLE 2

SYNTHESIS OF N-(6-DEOXY-D-GALACTOSE)-METHACRYLAMIDE

[0103] Using a similar procedure as outlined in Example 1, 6-amino-6-deoxy-D-glucose is reacted with methacrylic chloride to yield N-(6-deoxy-D-galactose)-methacrylamide.

EXAMPLE 3

SYNTHESIS OF N-(6-DEOXY-D-GALACTOSE)-ACRYLAMIDE

[0104] Using a similar procedure as outlined in Example 1 pyridine is replaced with 200 mmol of potassium carbonate to yield N-(6-deoxy-D-galactose)-acrylamide.

EXAMPLE 4

SYNTHESIS OF N-(3,4,5,6-TETRAHYDROXY-TETRAHYDRO-PYRAN-2-YLMETHYL)-ACRYLAMIDE

[0105] The present example outlines a method of synthesis of N-(3,4,5,6-tetrahydroxy-tetrahydro-pyran-2-ylmethyl)-acrylamide by means of a biphase system. N-(6-deoxy-D-galactose)-acrylamide is synthesized by means of acid chloride coupling. Anhydrous THF (500 mL) is added to a flame dried 1L three neck flask and

flooded with argon. To 150 mL of water is added 30.0 g (139.5 mmol) of anhydrous 6-amino-6-deoxy-D-galactose hydrochloride and the solution is neutralized with 3.4 g (139.6 mmol) sodium hydroxide and allowed to dissolve. A solution of 13.1 g (140.5 mmol) of acrylchloride in 100 mL of methylene chloride is added to the 6-amino-6-deoxy-D-galactose water solution at room temperature and stirred rapidly to form an emulsion. The reaction is allowed to proceed for five hours at 25 degrees Centigrade. The stirring is stopped and the phases are allowed to separate. The methylene chloride layer is extracted and the water layer is washed with three 25 mL portions of methylene chloride. The methylene chloride samples are combined, dried, and then the solvent is removed by rotary evaporation and high vacuum to yield N-(6-deoxy-D-galactose)-acrylamide.

EXAMPLE 5

SYNTHESIS OF 2-METHYL-N-[3,4,6-TRIHYDROXY-5-(2-METHYL-ACRYLOYLAMINO)-TETRAHYDRO-PYRAN-2-YLMETHYL]-ACRYLAMIDE

[0106] An outline of the synthesis is provided in **FIG. 5**. A multi-functional cross-linking agent is created from 2,6-diamino-2,6-dideoxy-D-glucose, methacrylic chloride and is mediated by an organic base. Anhydrous THF (500 mL) is added to a flame dried 1L three neck flask and flooded with argon. To the THF is added 38.6 g (153.7 mmol) of 2,6-diamino-2,6-dideoxy-D-glucose hydrochloride and 32.5 g (411.3 mmol) pyridine and allowed to dissolve. Then, by drop wise addition, 33.2 g (317.4 mmol) of methacrylic chloride in 55 mL of dry THF is added to the 2,6-diamino-2,6-dideoxy-D-galactose solution at -20 degrees Centigrade followed by warming to room temperature. The reaction is allowed to proceed for five hours at room temperature. The pyridinium chloride is then removed by filtration followed by washing and the solvents removed by rotary evaporation and high vacuum to yield N,N-(2,6-deoxy-D-glucose)-2,6-acrylamide.

EXAMPLE 6

SYNTHESIS OF N,N-(2,6-DEOXY-D-GALACTOSE)-2,6-ACRYLAMIDE

[0107] Using a similar procedure as outlined in Example 4, 2,6-diamino-2,6-dideoxy-D-galactose is reacted with acrylchloride to yield N,N-(2,6-deoxy-D-galactose)-2,6-acrylamide.

EXAMPLE 7

SYNTHESIS OF N,N-(2,6-DEOXY-D-GLUCOSE)-2,6-ACRYLAMIDE

[0108] Using a similar procedure as outlined in Example 4, pyridine is replaced with 412 mmol of potassium carbonate to yield N,N-(2,6-deoxy-D-glucose)-2,6-acrylamide.

[0109] In some embodiments, the acrylamide pyranose derivatives can be used as a hydrogel and/or polymer fixative in cosmetic products. In some embodiments, these compositions have increased safety. The following examples are directed to some such embodiments.

EXAMPLE 8

PREPARATION OF LINEAR ACRYLAMIDE PYRANOSE POLYMER (PAAP)

[0110] In a four-neck 500ml separable flask equipped with a mechanical stirrer, a dropping funnel, and a condenser, N-(6-deoxy-D-galactose)-acrylamide monomer (NMA), 20 g; distilled water, 50 ml; and tetrahydrofuran, 150ml, are combined. The flask is warmed up to 60 degrees Centigrade under air with stirring, and a specified amount of 2,2'-azobis(4-methoxy-2,4- dimethylvaleronitrile) is added as a polymerization initiator. The solution will change into a gel-like material in about 20 min. This point is tentatively taken as a standard for the end of reaction.

[0111] Disappearance of monomer at this point can be confirmed by silica gel thin layer chromatography (TLC). After the reaction, the reaction mixture is

concentrated under reduced pressure at room temperature, and remaining water in the viscous liquid is removed by freeze-drying to isolate poly(N-(6-deoxy-D-galactose)-acrylamide), pAAP, as a white solid.

EXAMPLE 9

PAAP HYDROGELS

[0112] 2.7 g of N-(6-deoxy-D-glucose)-acrylamide and 0.3 g of 2-methyl-N-[3,4,6-trihydroxy-5-(2-methyl-acryloylamino)-tetrahydro-pyran-2-ylmethyl]-acrylamide are added to 6 mL of distilled water and mixed thoroughly. Propylene glycol (3 ml) is added to the solution followed by the addition 0.2 g of Darocur 1173. The solution is then exposed to UV light at 350 nm for 5 min which initiates the polymerization thereby forming a hydrogel.

EXAMPLE 10

PAAP METHACRYLATE COPOLYMER

[0113] To a 3-neck reaction kettle outfitted with a condenser, argon inlet, and stirrer 10.0 g of N-(6-deoxy-D-galactose)-acrylamide, 4.0 g acrylic acid, 6.0 g of ethyl methacrylate, and 60 mL of THF are combined and mixed thoroughly. The solution is deoxygenated and warmed to 70 degrees Centigrade. To the warmed solution, 5 mL of a 5% AIBN in THF solution is added by dropwise addition. The reaction is allowed to proceed for 36 hours. The liquor is precipitated by a 50-50 mixture of ethanol/hexanes three times. The polymer is collected by filtration and dried under vacuum to yield a white solid of a PAAP methacrylate copolymer.

EXAMPLE 11

PAAP/SODIUM ACRYLOYLDIMETHYLTAURATE COPOLYMER

[0114] To a 3-neck reaction kettle outfitted with a condenser, argon inlet, and stirrer is added 10.0 g of N-(6-deoxy-D-galactose)-acrylamide, 6.0 g sodium acryloyldimethyltaurate and 60 mL of water and mixed thoroughly. The solution is

deoxygenated and warmed to 70 degrees Centigrade. To the warmed solution, 5 mL of a 6% (w/v) ammonium persulfate and 12% (w/v) sodium metabisulfite solution are added. The reaction is allowed to proceed for 36 hours. After the reaction, the reaction mixture is concentrated under reduced pressure at room temperature, and remaining water in the viscous liquid is removed by freeze-drying to isolate the copolymer as a white solid of PAAP/sodium acryloyldimethyltaurate copolymer.

[0115] While not limiting to the present scope, the following examples put forth exemplary sample formulations

EXAMPLE 12

SAMPLE HAIR SPRAY FORMULATION

[0116] A combination of Ethanol 34.0 wt. %, pAAP copolymer (Example 10) 8.0 wt. %, 2-amino-2-methyl-1- propanol 0.6 wt. %, fragrance 0.2 wt. %, n-pentane 8.0 wt. %, dimethyl ether 28.0 wt. %, water to 100.0% is prepared. Fragrance is a mixture of vanilla 34.8%, sandalwood 26.1%, French lavender 17.4%, jasmine 8.7%, ylang ylang 8.7% and dark musk was 4.2%.

EXAMPLE 13

SAMPLE HAIR SPRAY FORMULATION

[0117] A combination of ethanol 34.5 wt. %, pAAP linear polymer (Example 8) 8.2 wt. %, fragrance 0.2 wt. %, n-pentane 8.3 wt. %, dimethyl ether 27.6 wt. %, is mixed with water to 100.0%. Fragrance is a mixture of vanilla 34.8%, sandalwood 26.1%, French lavender 17.4%, jasmine 8.7%, ylang ylang 8.7% and dark musk was 4.2%. This provides a hair spray formulation.

EXAMPLE 14

SAMPLE SHAMPOO FORMULATION

[0118] To 26.0 g of 30% by weight solution of ammonium lauryl sulfate in water (99 g) is added 0.3 g fragrance mixture (vanilla 34.8%, sandalwood 26.1%, French lavender 17.4%, jasmine 8.7%, ylang ylang 8.7% and dark musk was 4.2%) to create a starting surfactant mixture (SSM). To 20.0 g of the SSM is added 3.0 g of 30% water solution of pAAP (Example 8) followed by 2.0 g of cocamide diethanolamine and then 5.0 g cocamidopropyl betaine. The pH is then adjusted to 5.7-6.1 using citric acid. This provides a shampoo formulation formulation.

EXAMPLE 15

SAMPLE SHAVING CREAM FORMULATION

[0119] A solution of 4.0 g glycerin, 1.0 g coco glucoside/glyceryl oleate, 4.0 g cetyl betaine, 5.0 g sodium cocosulfate, and 0.1 g tetrasodium EDTA is made and warmed to 70 degrees Centigrade. To this is added 0.1 g acrylamide pyranose copolymer from Example 11 with vigorous stirring. With continued mixing, 48.0 g of disodium lauryl sulfosuccinate is slowly added and mixed until homogenous. Then 0.5 g of a mixture of propylene glycol; diazolidinyl urea; iodopropynyl butyl carbomate is added followed by 0.5 g of sodium chloride and 0.3 g fragrance (vanilla 34.8%, sandalwood 26.1%, French lavender 17.4%, jasmine 8.7%, ylang ylang 8.7% and dark musk was 4.2%.). Mixing is continued until homogenous. This provides shaving cream formulation.

EXAMPLE 16

MASCARA FORMULATION

[0120] Mixture 1 is created by combining 6.0 g of mica black, 3.0 g of Ronastar Golden Sparks, 1.0 g of Ronastar Nobel sparks, and 2.0 g of satin mica. Mixture 2 is created by heating to 85 degrees Centigrade and mixing 3.0 g beeswax white, 3.5 g Syncrowax HRC, 5.0 g stearic acid, 3.5 g Tegin M, 2.5 g Tegosoft CT, 2.0 g Dow Corning 556, 0.5 g tocopherol acetate, and 0.8 g of phenonip. To mixture 2 is added 3.5 g of pAAP copolymer powder from Example 11. Mixture 3 is created from 59.2 g of

water, 1.25 g 2-amino-2-methyl-1-propanol, 1.0 g 1,3-butanediol, and 0.5 g RonaCare Biotin Plus. Mixture 4 is created from 0.3 g of Germall 115 and 1.5 g of water.

[0121] Mixture 3 is heated to 85 degrees Centigrade and mixture 1 added to mixture 3 with vigorous stirring. The combined mixture of 1 and 3 are added to mixture 2 at 85 degrees Centigrade with stirring. The mixture is cooled to 40 degrees Centigrade and mixture 4 is then added. Continue stirring until homogenous and cool to room temperature. This produces a mascara formulation.

EXAMPLE 17

POLYMERIZED ACRYLAMIDE AND METHACRYLAMIDE

[0122] The acrylamide of the 6-amino-D-glucose and the methacrylamide of the 6-amino-D-glucose are separately collected and are separately polymerized in water as a 20% solution using 4,4'-azobis(4-cyanovaleric acid) at 75 degree Centigrade under argon. This produces the resulting polymer of the acrylamide of the 6-amino-D-glucose and the polymer of the methacrylamide of the 6-amino-D-glucose.

[0123] Unless otherwise specified, the section headings are not to be taken as excluding the combinations and/or variations of embodiments in other sections and are being used for convenience only. In regard to the text and figures of the detailed description, in some embodiments, the structures depicted as bis amino derivatives can be applied in a mono amino setting, simply by the removal of one of the nitrogen groups. Similarly, the structures depicted as mono amino derivatives can be applied in a bis amino setting, simply by the addition of one nitrogen group as appropriate. Similarly, compositions and/or monomer embodiments can be formed into their polymeric versions (in either a homogeneous or heterogeneous manner) and that the polymers depicted also describe the monomeric forms. These aspects, of course, do not apply to the claims.

[0124] The present disclosure is not to be limited in terms of the particular embodiments described in this application, which are intended as illustrations of various aspects. Many modifications and variations can be made without departing from its spirit and scope, as will be apparent to those skilled in the art. Functionally equivalent methods and apparatuses within the scope of the disclosure, in addition to those enumerated

herein, will be apparent to those skilled in the art from the foregoing descriptions. Such modifications and variations are intended to fall within the scope of the appended claims. The present disclosure is to be limited only by the terms of the appended claims, along with the full scope of equivalents to which such claims are entitled. It is to be understood that this disclosure is not limited to particular methods, reagents, compounds, compositions or biological systems, which can, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting.

[0125] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0126] It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (*e.g.*, bodies of the appended claims) are generally intended as "open" terms (*e.g.*, the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (*e.g.*, "a" and/or "an" should be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will

recognize that such recitation should be interpreted to mean at least the recited number (*e.g.*, the bare recitation of "two recitations," without other modifiers, means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (*e.g.*, " a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (*e.g.*, " a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

[0127] In addition, where features or aspects of the disclosure are described in terms of Markush groups, those skilled in the art will recognize that the disclosure is also thereby described in terms of any individual member or subgroup of members of the Markush group.

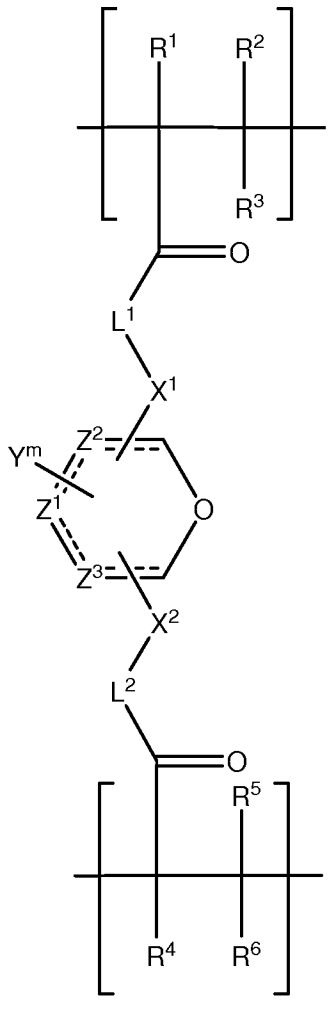
[0128] As will be understood by one skilled in the art, for any and all purposes, such as in terms of providing a written description, all ranges disclosed herein also encompass any and all possible subranges and combinations of subranges thereof. Any listed range can be easily recognized as sufficiently describing and enabling the same range being broken down into at least equal halves, thirds, quarters, fifths, tenths, etc. As a non-limiting example, each range discussed herein can be readily broken down into a lower third, middle third and upper third, etc. As will also be understood by one skilled in the art all language such as "up to," "at least," and the like include the number recited and refer to ranges which can be subsequently broken down into subranges as

discussed above. Finally, as will be understood by one skilled in the art, a range includes each individual member. Thus, for example, a group having 1-3 cells refers to groups having 1, 2, or 3 cells. Similarly, a group having 1-5 cells refers to groups having 1, 2, 3, 4, or 5 cells, and so forth.

[0129] From the foregoing, it will be appreciated that various embodiments of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various embodiments disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

CLAIMS

1. A cosmetic composition comprising a polymer and at least one cosmetic additive, wherein the polymer comprises one or more cross-linked monomer units, wherein the cross-linked monomer units are represented by Formula I:



(I)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

X^2 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

L^2 is -NH-, S, or O;

each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted

version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, and C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18;

Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2;

R^1, R^2, R^3, R^4, R^5, and R^6 are each optionally substituted and independently are hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl or C_2-C_{24} alkynyl; and

wherein each ------ is a double bond or a single bond.

2. The cosmetic composition of Claim 1, wherein Z1 is -CH2-, -CHYm-, or –CYmYm-.

3. The cosmetic composition of Claims 1 or 2, wherein Z2 is -CH2-, -CHYm-, or –CYmYm-.

4. The cosmetic composition of any one of Claims 1-3, wherein Z3 is -CH2-, -CHYm-, –CYmYm-, or –CHX2-

5. The cosmetic composition of any one of Claims 1-4, wherein Z3 is -CHX2-.

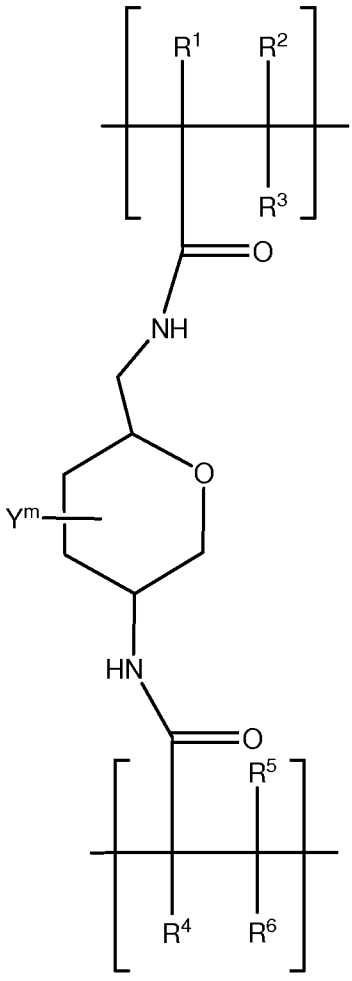
6. The cosmetic composition of any one of Claims 1-5, wherein Z1, Z2, and Z3 are each –CH(OH)-.

7. The cosmetic composition of any one of Claims 1-6, wherein L1 is -NH-.

8. The cosmetic composition of any one of Claims 1-7, wherein L2 is -NH-.

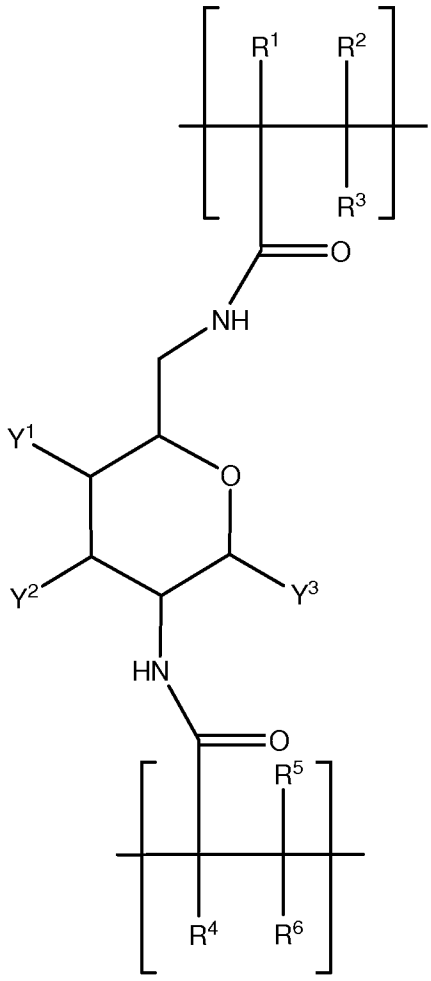
9. The cosmetic composition of any one of Claims 1-8, wherein each ------ is a single bond.

10. The cosmetic composition of any one of Claims 1-9, wherein the cross-linked monomer units are represented by Formula II:



(II).

11. The cosmetic composition of any one of Claims 1-10, wherein the cross-linked monomer units are represented by Formula III:



(III)

wherein Y^1, Y^2, and Y^3 are each independently Y^m.

12. The cosmetic composition of Claim11, wherein Y^1, Y^2, and Y^3 are each hydroxy.

13. The cosmetic composition of any one of Claims 1-12, wherein R^1 is hydrogen or methyl.

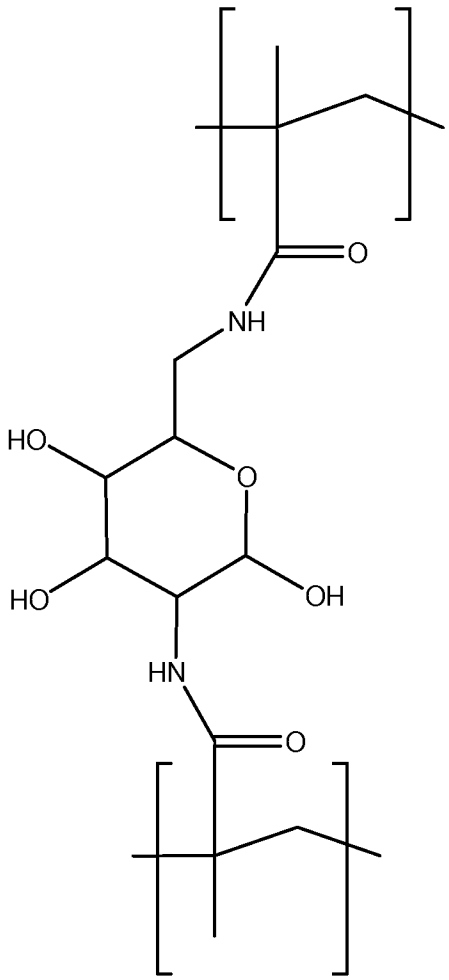
14. The cosmetic composition of any one of Claims 1-13, wherein R^4 is hydrogen or methyl.

15. The cosmetic composition of any one of Claims 1-14, wherein R^1 is methyl, R^4 is methyl, R^3 is hydrogen, and R^6 is hydrogen.

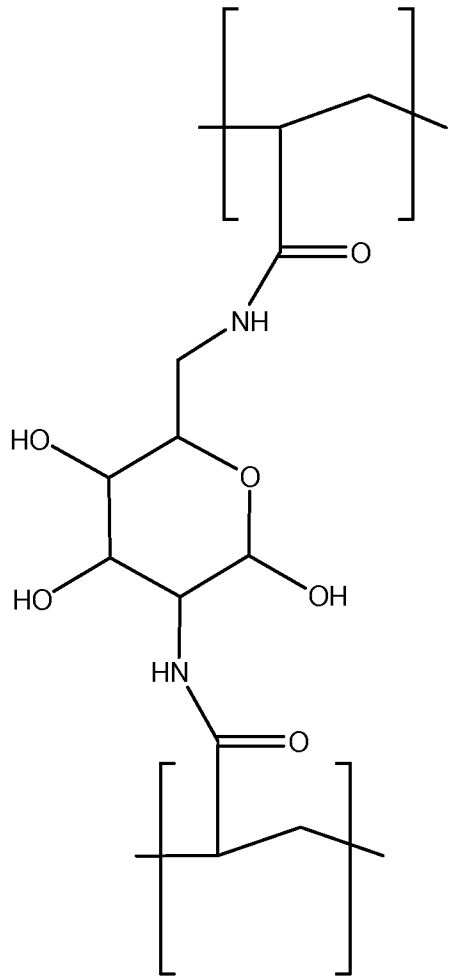
16. The cosmetic composition of any one of Claims 1-15, wherein R^2, R^3, R^5, and R^6 are each hydrogen.

17. The cosmetic composition of any one of Claims 1-16, wherein the polymer comprises less than about 1% by weight of acrylamide monomer units.

18. The cosmetic composition of Claim 1, wherein the cross-linked monomer units are represented by Formula IV or V:

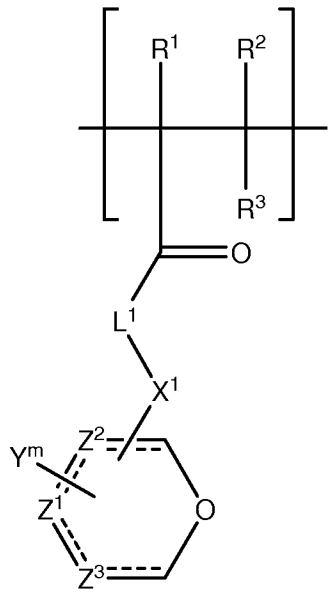


(IV)



(V).

19. A cosmetic composition comprising a polymer and at least one cosmetic additive, wherein the composition comprises less than about 0.2% by weight of acrylamide monomer, and wherein the polymer comprises a monomer unit represented by Formula VI:



(VI)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_x$, -$S(O)_xR^C$, -$OS(O)_x$, -$NS(O)_x$, -$NS(O)_xR^C$, -$P(O)_xR^C$, -$OP(O)_x$, -$NP(O)_x$, -$NP(O)_xR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each x is independently one, two, or three, and m is an integer from 0 to 19;

Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1;

R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl C_2-C_{24} alkynyl, or a substituted version thereof; and

wherein each ------ is a double bond or a single bond.

20. The cosmetic composition of Claim 19, wherein Z^1 is $-CH_2-$, $-CHY^m-$, or $-CY^mY^m-$.

21. The cosmetic composition of Claims 19 or 20, wherein Z^2 is $-CH_2-$, $-CHY^m-$, or $-CY^mY^m-$.

22. The cosmetic composition of any one of Claims 19-21, wherein Z^3 is $-CH_2-$, $-CHY^m-$, $-CY^mY^m-$, or $-CHX^2-$.

23. The cosmetic composition of any one of Claims 19-22, wherein Z^3 is $-CX^2-$.

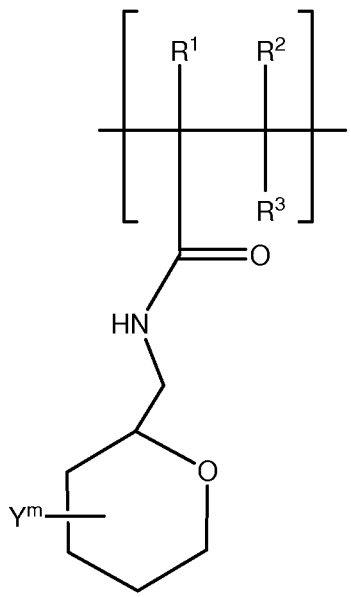
24. The cosmetic composition of any one of Claims 19-23, wherein Z^1, Z^2, and Z^3 are each –CH(OH)-.

25. The cosmetic composition of any one of Claims 19-24, wherein L^1 is -NH-.

26. The cosmetic composition of any one of Claims 19-25, wherein L^2 is -NH-.

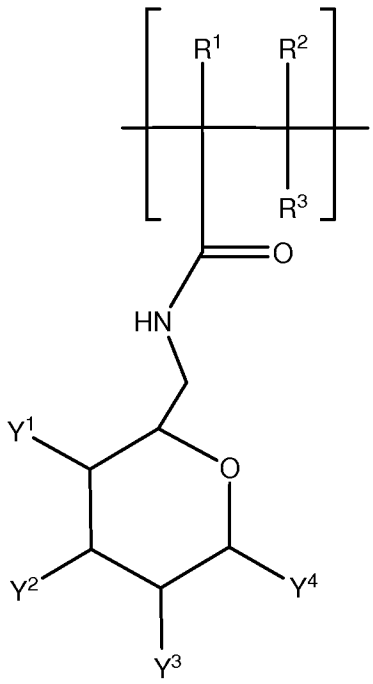
27. The cosmetic composition of any one of Claims 19-26, wherein each ------ is a single bond.

28. The cosmetic composition of any one of Claims 19-27, wherein the monomer unit is represented by Formula VII:



(VII).

29. The cosmetic composition of any one of Claims 19-28, wherein the monomer unit is represented by Formula VIII:



(VIII)

wherein Y^1, Y^2, Y^3, and Y^4 are each independently Y^m.

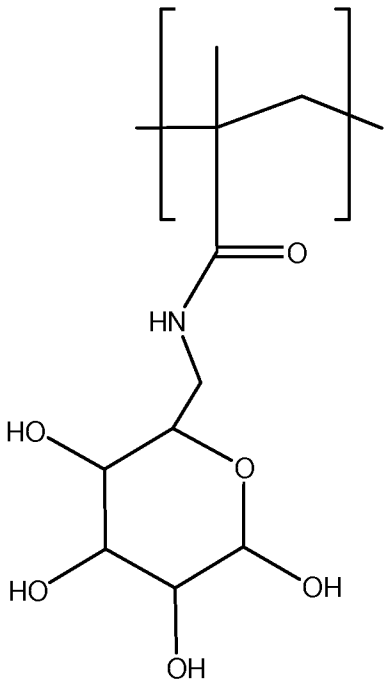
30. The cosmetic composition of Claim 29, wherein Y^1, Y^2, Y^3, and Y^4 are each hydroxy.

31. The cosmetic composition of any one of Claims 19-30, wherein R^1 is hydrogen or methyl.

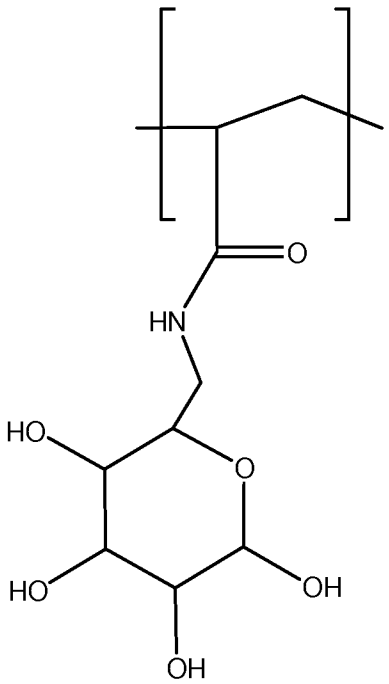
32. The cosmetic composition of any one of Claims 19-31, wherein R^2 is hydrogen R^3 is hydrogen.

33. The cosmetic composition of any one of Claims 19-32, wherein the polymer comprises less than about 1% by weight of acrylamide and methacrylamide monomer units.

34. The cosmetic composition of any one of Claims 19-33, wherein the polymer comprises a monomer unit represented by Formula IX or X:

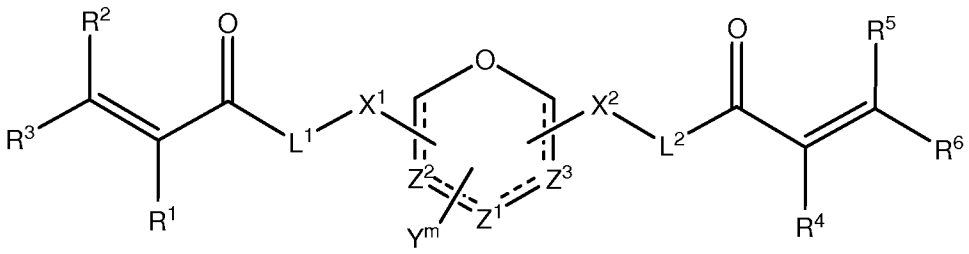


(IX)



(X).

35. A compound represented by Formula XI:



(XI)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

X^2 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

L^2 is -NH-, S, or O;

each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6

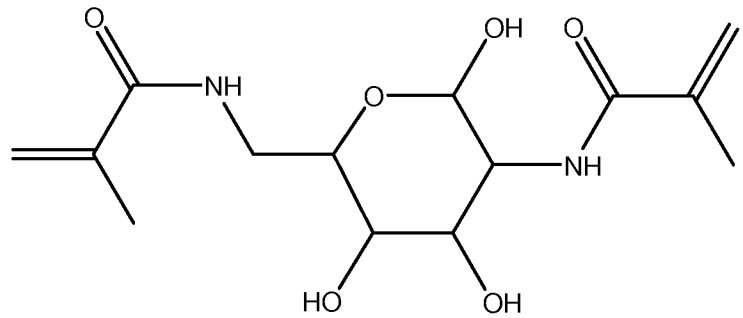
alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer 0 to 18;

Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2;

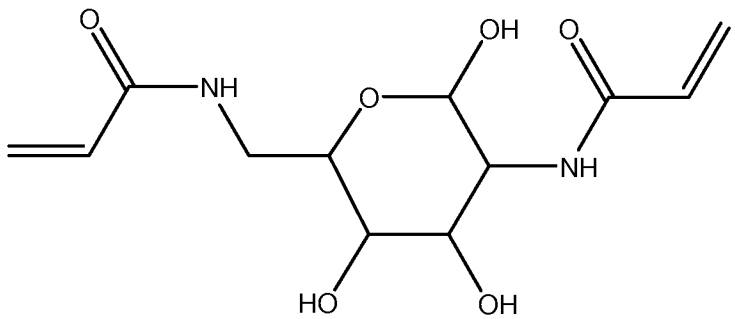
R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and

wherein each ------ is a double bond or a single bond.

36. The compound of Claim 35, represented by Formula XII or XIII:

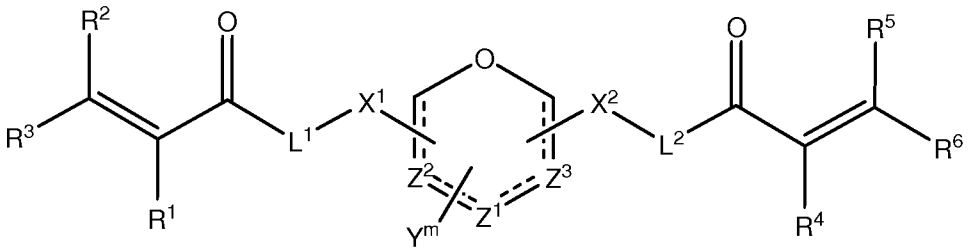


(XII)

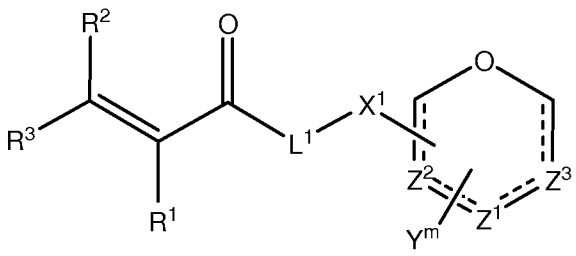


(XIII).

37. A method of preparing a polymer, the method comprising polymerizing one or more monomers to form a polymer, wherein the one or more monomers include a first monomer selected from the group consisting of a monomer represented by Formula XIV, a monomer represented by Formula XV, and combinations thereof:



(XIV)



(XV)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

X^2 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

L^2 is -NH-, S, or O;

each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18;

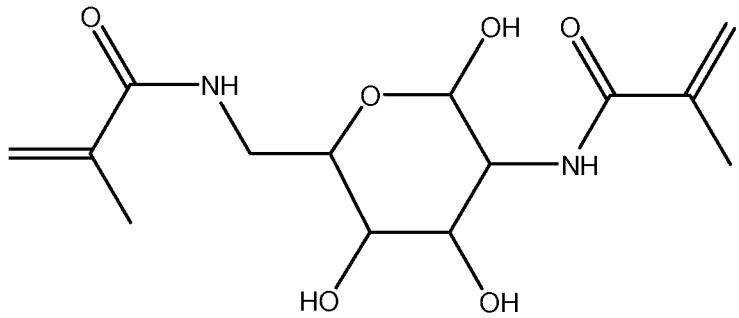
Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2;

R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and

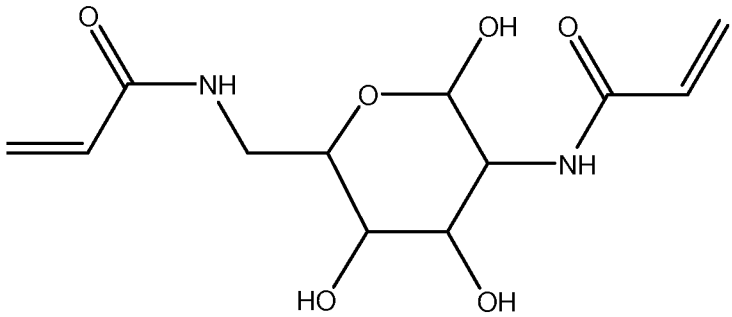
wherein each ------ is a double bond or a single bond.

38. The method of Claim 37, wherein the one or more monomers do not include methacrylamide or acrylamide.

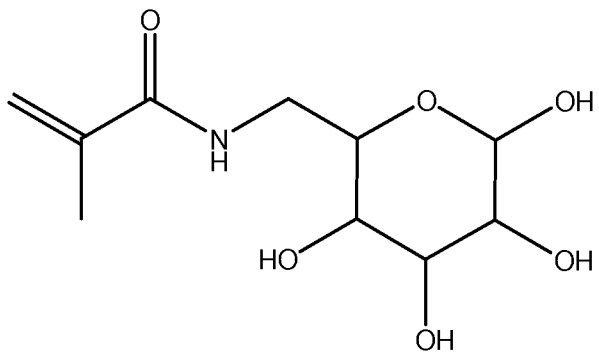
39. The method of Claim 37, wherein the one or more monomers are represented by Formula XVI, XVII, XVIII or XIX:



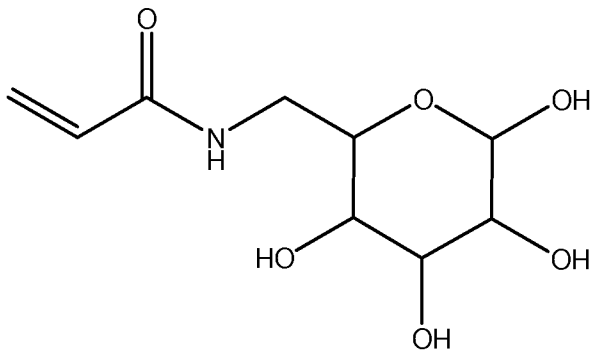
(XVI)



(XVII)



(XVIII)



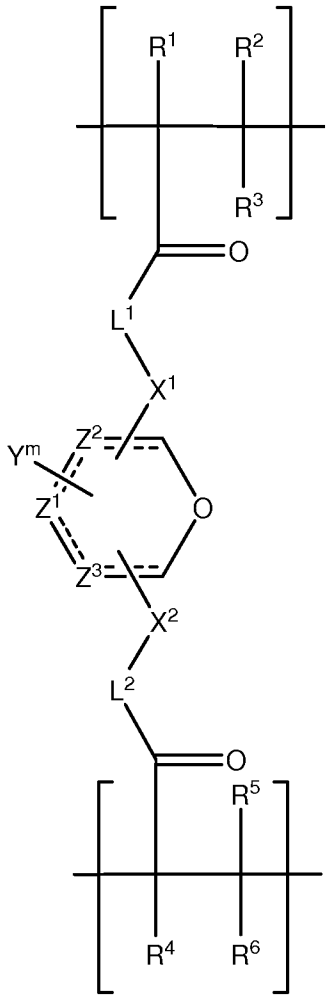
(XIX).

40. A method of providing nutrients to skin, the method comprising:

providing a cosmetic composition comprising a polymer; and:

applying the cosmetic composition to a subject's skin to provide nutrients to the subject's skin,

wherein the polymer comprises one or more cross-linked monomer units, and wherein the cross-linked monomer units are represented by Formula XX:



(XX)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

X^2 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

L^2 is -NH-, S, or O;

each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -

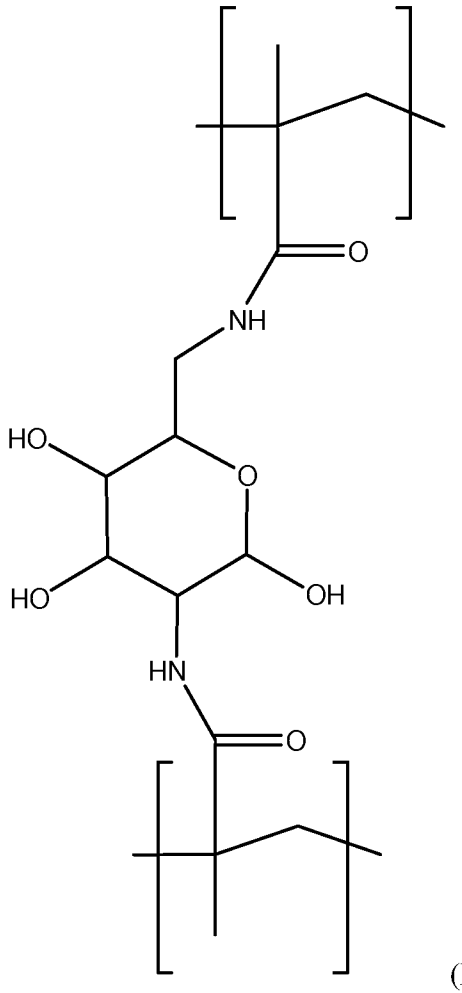
R^CSR^A, $-S(O)_q$, $-S(O)_qR^C$, $-OS(O)_q$, $-NS(O)_q$, $-NS(O)_qR^C$, $-P(O)_qR^C$, $-OP(O)_q$, $-NP(O)_q$, $-NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or $-C_{1-6}$ alkylene-, wherein each q is independently one, two, or three, and n is an integer from 0 to 18;

Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, $-CH_2-$, $-CH(OH)-$, $-CH=$, $-CH_2-CH_2-$, $=CH-CH_2-$, $=CH-CH=$, $-CH=CH-$, $-CH_2-CH_2-CH_2-$, $=CH-CH_2-CH_2-$, $=CH-CH_2-CH=$, $=CH-CH=CH-$, or $-CH=CH_2-CH_2-$ wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2;

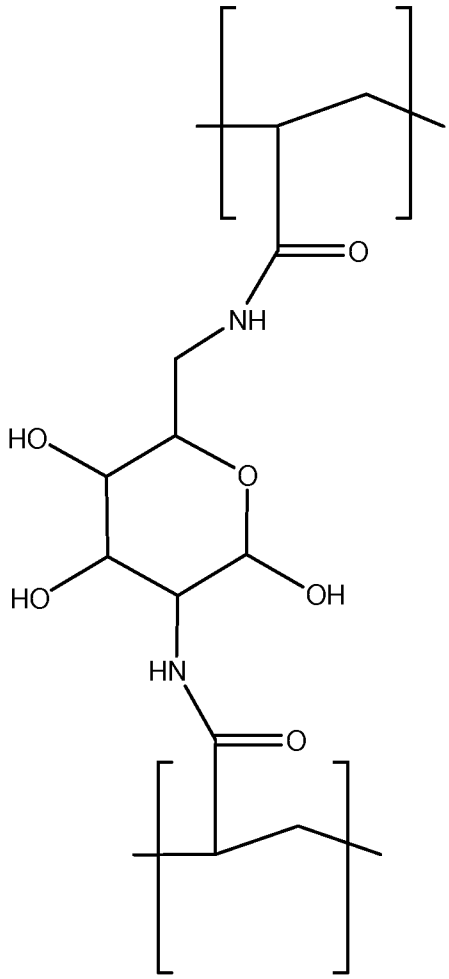
R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and

wherein each ------ is a double bond or a single bond.

41. The method of Claim 40, represented by Formula XXI or XXII:



(XXI)



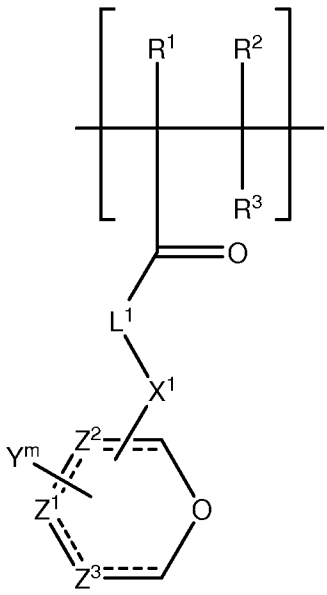
(XXII).

42. A method of providing nutrients to skin, the method comprising:

providing a cosmetic composition comprising a polymer, wherein the composition comprises less than about 0.2% by weight of acrylamide; and

applying the cosmetic composition to a subject's skin to provide one or more nutrients to the subject's skin,

wherein the polymer comprises one or more monomer units represented by Formula XXIII:



(XXIII)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

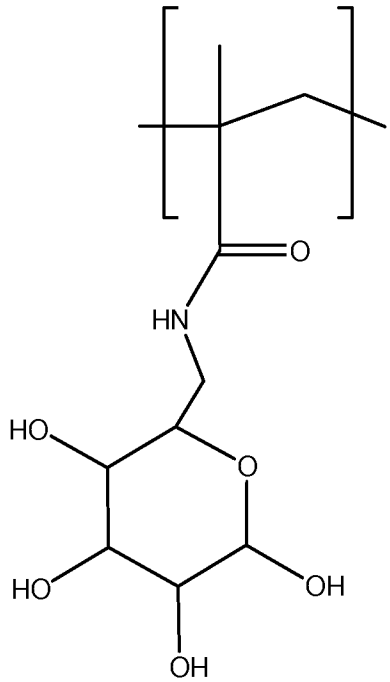
each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and n is an integer from 0 to 19;

Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2;

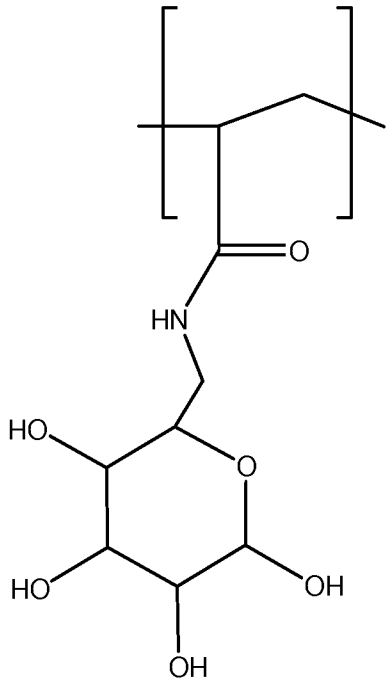
R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and

wherein each ------ is a double bond or a single bond.

43. The method of Claim 42, represented by Formula XXIV or XXV:

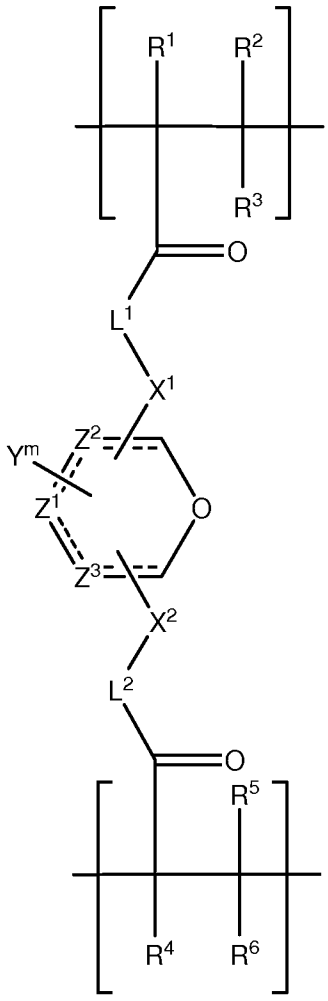


(XXIV)



(XXV).

44. A polymer comprising one or more cross-linked monomer units, wherein the cross-linked monomer units are represented by Formula XXVI:



(XXVI)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

X^2 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

L^2 is -NH-, S, or O;

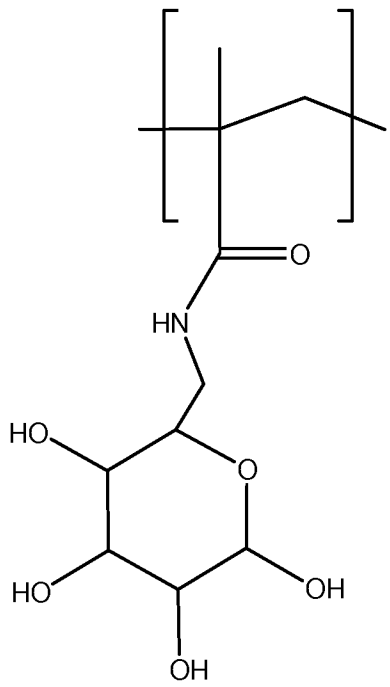
each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_q$, -$S(O)_qR^C$, -$OS(O)_q$, -$NS(O)_q$, -$NS(O)_qR^C$, -$P(O)_qR^C$, -$OP(O)_q$, -$NP(O)_q$, -$NP(O)_qR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each q is independently one, two, or three, and m is an integer from 0 to 18;

Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1 or X^2;

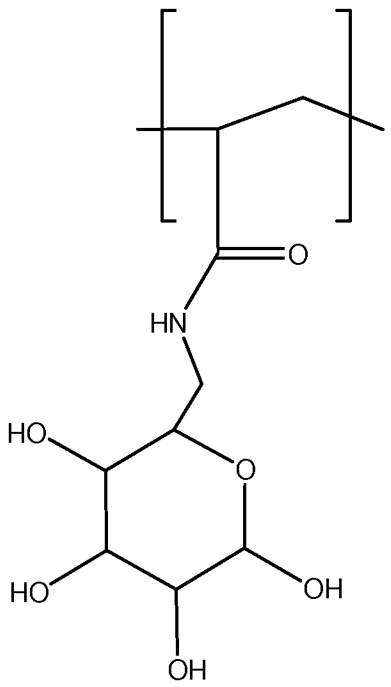
R^1, R^2, R^3, R^4, R^5, and R^6 are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and

wherein each ------ is a double bond or a single bond.

45. The polymer of Claim 44, wherein the polymer comprises a monomer unit represented by Formula XXVII or XXVIII:

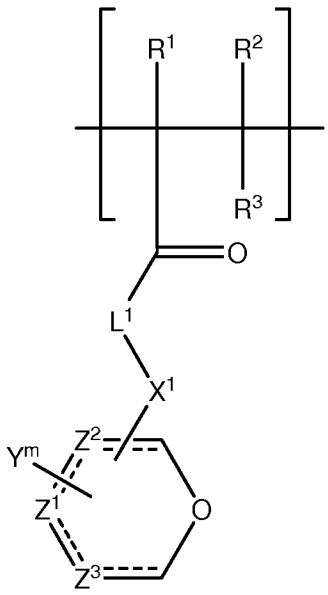


(XXVII)



(XXVIII).

46. A polymer comprising a monomer unit represented by Formula XXIX:



(XXIX)

wherein:

X^1 is a bond or -C_{1-6} alkylene-;

L^1 is -NH-, S, or O;

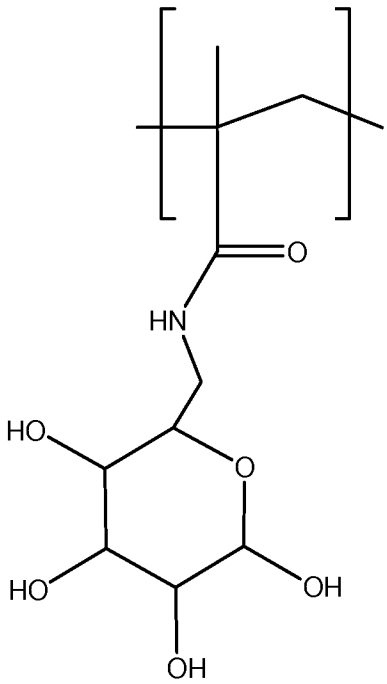
each Y^m is independently hydrogen, hydroxy, saturated C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, -NR^AR^B, -$NR^AC(O)R^B$, -$R^CNR^AR^B$, -$R^CNR^AC(O)R^B$, -$C(O)NR^AR^B$, -$OC(O)NR^AR^B$, -$C(O)R^A$, -$R^CC(O)R^A$, -$R^COC(O)R^A$, -$C(O)OR^A$, -$R^CC(O)OR^A$, -OR^A, -R^COR^A, -SR^A, -R^CSR^A, -$S(O)_x$, -$S(O)_xR^C$, -$OS(O)_x$, -$NS(O)_x$, -$NS(O)_xR^C$, -$P(O)_xR^C$, -$OP(O)_x$, -$NP(O)_x$, -$NP(O)_xR^C$, or a substituted version thereof, wherein each R^A and R^B is independently hydrogen, C_1-C_6 alkyl, unsaturated C_2-C_6 alkenyl, or C_2-C_6 alkynyl, each R^C is a bond, or -C_{1-6} alkylene-, wherein each x is independently one, two, or three, and m is an integer from 0 to 19;

Z^1, Z^2, and Z^3 are each independently a single bond, a double bond, -CH_2-, -CH(OH)-, -CH=, -CH_2-CH_2-, =CH-CH_2-, =CH-CH=, -CH=CH-, -CH_2-CH_2-CH_2-, =CH-CH_2-CH_2-, =CH-CH_2-CH=, =CH-CH=CH-, or -CH=CH_2-CH_2- wherein each of Z^1, Z^2, and Z^3 is optionally substituted with one, two, three or four of Y^m, and wherein each of Z^1, Z^2, and Z^3 is optionally substituted with X^1;

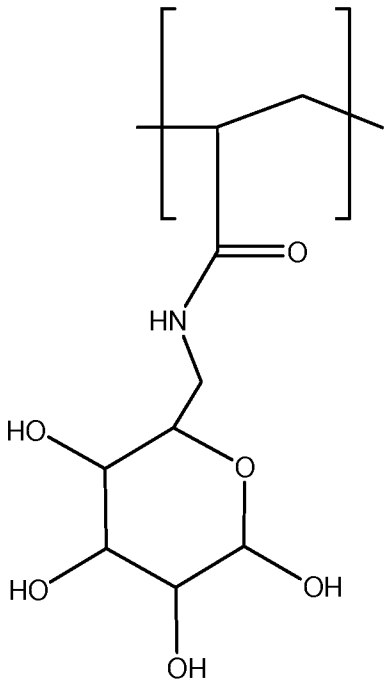
R^1, R^2, and R^3, are each independently hydrogen, C_1-C_{24} alkyl, unsaturated C_2-C_{24} alkenyl, C_2-C_{24} alkynyl, or a substituted version thereof; and

wherein each ------ is a double bond or a single bond.

47. The polymer of Claim 46, wherein the polymer comprises a monomer unit represented by Formula XXX or XXXI:



(XXX)



(XXXI).

48. A cosmetic composition comprising:

a pyranose polyacrylamide polymer or a pyranose polymethacrylamide polymer; and

at least one cosmetic additive.

49. The cosmetic composition of Claim 48, wherein the composition comprises less than about 0.2% by weight of acrylamide.

50. A method of providing nutrients to skin, the method comprising:

providing a cosmetic composition comprising:

a pyranose polyacrylamide polymer or a pyranose polymethacrylamide polymer; and

at least one cosmetic additive, wherein the composition comprises less than about 0.2% by weight of acrylamide; and

applying the cosmetic composition to a subject's skin to provide nutrients to the subject's skin.

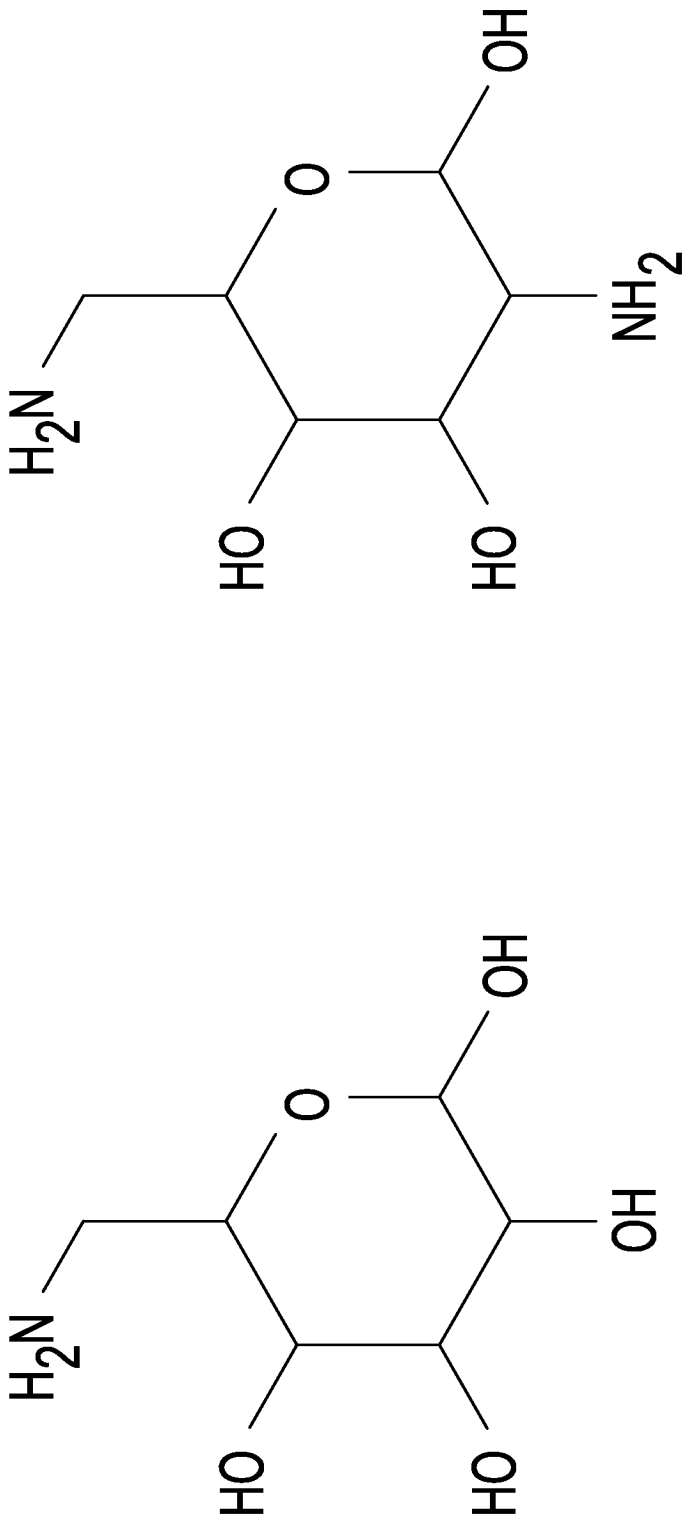


FIG. 1

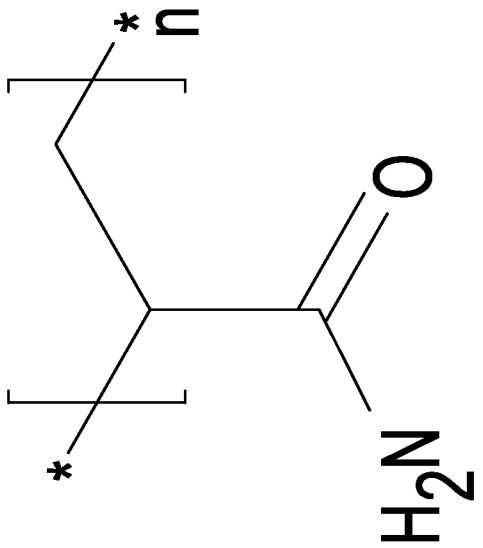
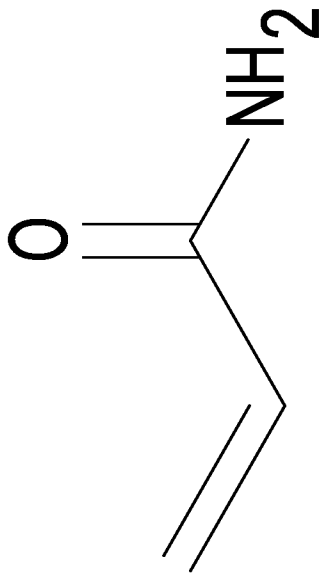


FIG. 2



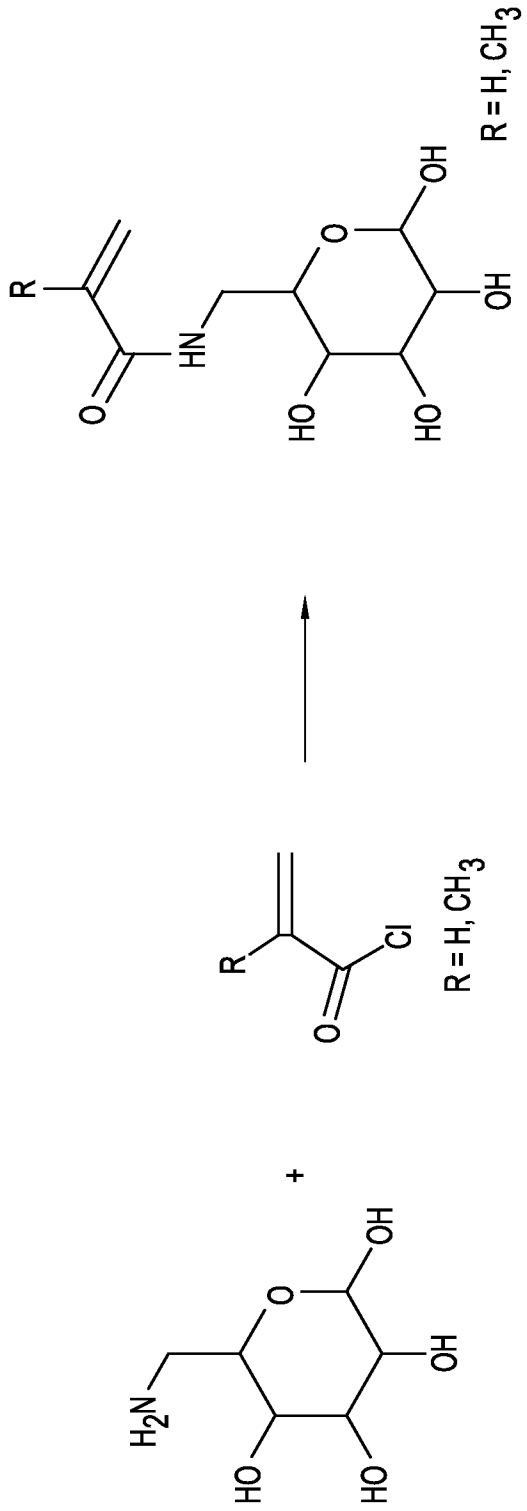


FIG. 3

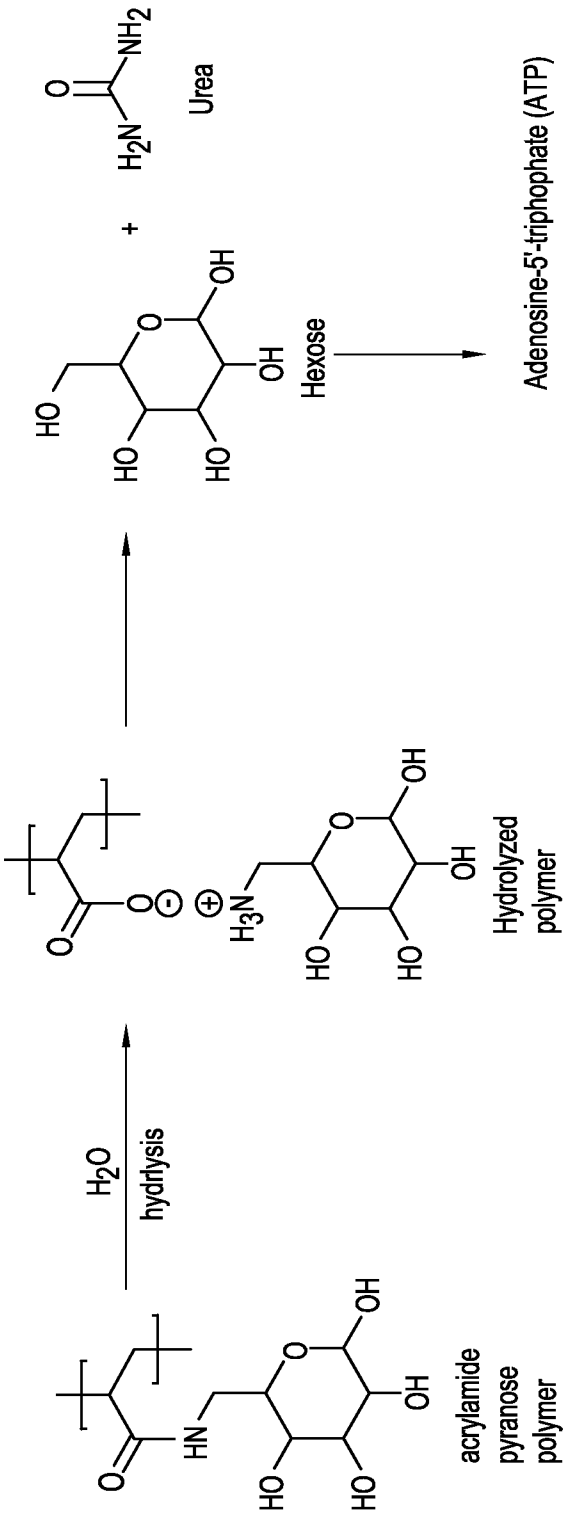

acrylamide pyranose polymer
H_2O hydrlysis
Hydrolyzed polymer less acidic than PLGA or HEMA
Urea
Hexose
Adenosine-5'-triphophate (ATP)

FIG. 4

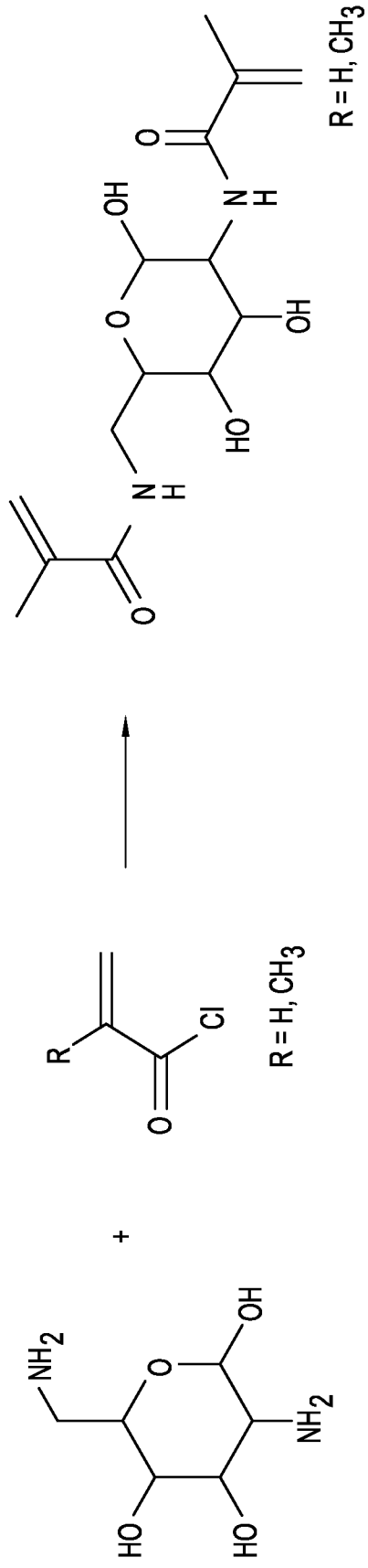


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/63211

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61K 47/26; C08F 20/56; C08F 120/56; C08F 220/56 (2013.01)
USPC - 523/108; 524/543; 525/54.2; 536/1.11
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(8) -A61K 47/26; C08F 20/56; C08F 120/56; C08F 220/56; (2013.01)
USPC -523/108; 524/543; 525/54.2; 536/1.11;

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC -523/108; 524/543; 525/54.2; 536/1.11; (see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Scholar, Google Patents, WIPO (pyranose, acrylamide, cosmetic, skin, monomer, polymer, sugar, cross-link, tetrahydropyrna, polyacrylamide, carbohydrate, nutrients, methylacrylamide, pyranoside, glycoside)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 6,552,103 B1 (BERTOZZI, et al.) 22 April 2003 (22.04.2003) entire document, especially col 4, ln 10-30, 34-50; col 5, ln 40-51, 54-57; col 6, ln 35-47; col 9; col 11, ln 27-35; col 13, ln 13-29; col 21, ln 7-10	47b ---------- 1-3, 18-21, 35-42, 44, 46, 48-49
Y	US 2011/0282048 A1 (BRUMER, et al.) 17 November 2011 (17.11.2011) entire document, especially para [0044], [0047]-[0048], [0076], [0172], [0239]	1-3, 18-21, 35-42, 44, 46
Y	US 2002/0111281 A1 (VISHNUPAD) 15 August 2002 (15.08.2002) entire document, especially para[0002], [0004], [0006], [0011], [0014]-[0015], [0017], [0020]	19-21, 40-42, 48-49
A	US 2010/0003236 A1 (DALKO, et al.) 07 January 2010 (07.01.2010) entire document	1-3, 18-21, 35-42, 44, 46, 47b and 48-49

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 March 2013 (06.03.2013)	15 MAR 2013
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 12/63211

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-17, 22-34
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

-----See extra Sheet----

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
Claims 1-3, 18-21, 35-42, 44, 46, 47b and 48-49, restricted to compounds of Formula VI in claim 19 where Ym is hydroxy and -NR.sup.A.-C(O)-R.sup.B.-, as seen in Formulas XVI and XVII of claim 39

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US 12/63211

Continuation of Box III:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I+: Claims 1-3, 18-21 and 35-49 are drawn to methods and compositions related to polymers derived from the acrylamide-derivative monomers represented by Formulas I-XXXI.

The first invention is restricted to compounds of Formula VI in claim 19 where Ym is hydroxy and -NR.sup.A.-C(O)-R.sup.B.-, as seen in Formulas XVI and XVII of claim 39, comprising claims 1-3, 18-21, 35-42, 44, 46, 47b and 48-49. Applicant may instead elect other embodiments of the compound of Formula VI in claim 19 where Ym is other than -NR.sup.A.-C(O)-R.sup.B.-. Specifically, applicant may instead elect compounds of Formula VI in claim 19 where Ym is only hydroxy, as seen in Formulas XVIII and XIX of claim 39, comprising claims 19-21, 37-39, 42-43, 45-46, 47a, 47b and 48-49. Applicant may also instead elect compounds of Formula VI in claim 19 where Ym is any other moiety claimed therein, other than hydroxy or -NR.sup.A.-C(O)-R.sup.B.-, comprising claims 19-21, 42, 46, 47b, and 48-49.

Should an additional fee(s) be paid, Applicant is invited to elect additional compound(s) to be searched, as set forth above.

The inventions listed as Group I+ do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The inventions of Group I+ share the technical feature of being drawn to polymers derived from the acrylamide-derivative monomers represented by Formulas I-XXXI, such as Formula VI in claim 19 where Ym is hydroxy, as seen in Formulas XVIII and XIX of claim 39. Embodiments of the inventions of Group I+ also share the technical features of being drawn to methods comprising polymerizing one or more of the monomers to form a polymer. However, these shared technical features do not represent a contribution over prior art as being anticipated by US 6,552,103 B1 to Bertozzi et al. (hereinafter 'Bertozzi'), which discloses a polymerizable, acrylamide-functionalized carbohydrate monomer (col 5, ln 1-3 and 45-50) which is the same as the compounds of Formulas XVIII and XIX of claim 39. Bertozzi also discloses polymerization of the monomers into a polymer (col 2, ln 16-20), and the use of the polymers in cosmetic applications (Col 17, ln 12).

Other embodiments of the inventions of Group I+ also share the technical features of being drawn to cosmetic compositions comprising the polymers and at least one cosmetic additive; and to methods of providing nutrients to skin comprising applying a cosmetic composition comprising the polymer to a subject's skin to provide nutrients to the subject' s skin. However, the use of acrylamide-based polymers ans carbohydrate derivatives in cosmetic applications, such as for the delivery of nutrients to the skin of a subject, is known and routine to those with ordinary skill in the art. This common use is shown by Bertozzi, which specifically discloses the use of the polymers in cosmetic applications (Col 17, ln 12). This common use is also shown by US 2006/0165632 A1 (Mehul), which discloses a cosmetic composition comprising a carbohydrate derivative component, (para [0014] and [0019]), polyacrylamide gelling agents (para [0043]), and a variety of additional cosmetic and nutrient additives (para [0039]) which can applied topically to the skin of the subject (para [0002]).

Thus, as said compositions and their cosmetic uses were known in the art at the time of the invention, as evidenced by the disclosures of Bertozzi and Mehul, these cannot be considered a special technical feature that would otherwise unify the groups. Group I+ therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.

****

Claims 4-17 and 22-34 are unsearchable because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

****

The application includes two instances of claim 47, each with different claim limitations. For the purposes of this opinion, the claims are listed as 47a and 47b. Furthermore, claim 48 is written to depend from claim 47. For the purposes of this opinion, claim 48 is analyzed as depending from claim 47b.