Accordingly, there is a need for a hydrogel material that addresses or alleviates one or more disadvantages mentioned above. There is a need to provide a hydrogel material having desirable properties.

Summary of Invention

According to the present disclosure, there is provided a polymeric composition comprising a plurality of metallic cross-linked monomers in the presence of a stabilizing agent, wherein said monomers are selected from (a) a carboxylic acryloyl monomer; (b) a sulfonic acryloyl monomer; (c) an amine acryloyl monomer; (d) a hydroxyl acryloyl monomer; (e) an alkyl acryloyl monomer; and (f) a polyalkylene hydroxyl acryloyl monomer.

According to a first aspect, there is provided a polymeric composition comprising a plurality of monomers in the presence of a stabilizing agent, wherein said monomers comprise each of a) an alkaline earth metallic cross-linked carboxylic acryloyl monomer; b) an alkaline earth metallic cross-linked sulfonic acryloyl monomer; c) an amine acryloyl monomer; d) a hydroxyl acryloyl monomer; e) an alkyl acryloyl monomer; and f) a polyalkylene hydroxyl acryloyl monomer.

Advantageously, the polymeric composition, when used on implanted materials, may have good anti-fouling property and biocompatibility to prolong the lifetime of implanted materials. The polymeric composition may have antimicrobial properties to eliminate infection and inflammation. The polymeric composition may have good mechanical property to avoid failure of the implanted material.

Advantageously, the use of the stabilizing agent such as a zwitterionic monomer may confer an overall charge neutrality to the polymeric composition since the zwitterionic monomer has both a positively charged moiety and a negatively charged moiety within the same side chain segment. As a result, the resultant polymeric composition has homogeneously distributed and balanced positive and negative charges, which may result in the anti-fouling property of the polymeric composition. This may lead to the polymeric composition having a high resistance against protein adsorption, bacteria adhesion and cell adhesion to thereby prevent biofouling.

Advantageously, the polymeric composition may be used as an anti-fouling hydrogel coating material. The polymeric composition, when used as an anti-fouling hydrogel coating material, may be safe, may elicit little inflammatory response *in vivo*, may resist capsule formation and/or may elicit minimal foreign body reaction *in vivo*. Furthermore, the polymeric composition when used as an anti-fouling hydrogel coating material, may have a longer *in vivo* lifetime as compared to conventional anti-fouling materials, may demonstrate very good resistance against non-specific protein adsorption, bacteria adhesion and cell adhesion, and display good biocompatibility *in vitro*, may be of soft elastic nature to be moulded into various shapes, may be of great transparency, may be of chemically defined (hence, not eliciting any immune response in a human or animal body), may be of low cost, and/or easier to prepare or operate.

According to the present disclosure, there is provided a method for forming a polymeric composition comprising a plurality of metallic cross-linked monomers in the presence of a stabilizing agent, wherein said monomers are selected from (a) a carboxylic acryloyl monomer; (b) a sulfonic acryloyl monomer; (c) an amine acryloyl monomer; (d) a hydroxyl acryloyl monomer; (e) an alkyl acryloyl monomer; and (f) a polyalkylene

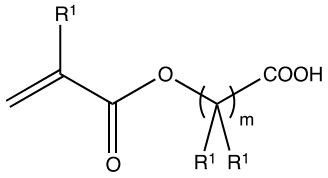
hydroxyl acryloyl monomer, wherein the method comprises the steps of (i) providing a solution mixture of the carboxylic acryloyl monomer, the sulfonic acryloyl monomer, the amine acryloyl monomer, the hydroxyl acryloyl monomer, the alkyl acryloyl monomer, the polyalkylene hydroxyl acryloyl monomer, the stabilizing agent and a source of a metallic cross-linker; and (ii) polymerizing said solution mixture with an acid initiator to thereby synthesize said polymeric composition.

According to another aspect, there is provided a method for forming a polymeric composition comprising a plurality of monomers in the presence of a stabilizing agent, wherein said monomers comprise each of: (a) an alkaline earth metallic cross-linked carboxylic acryloyl monomer; (b) an alkaline earth metallic cross-linked sulfonic acryloyl monomer; (c) an amine acryloyl monomer; d) a hydroxyl acryloyl monomer; (e) an alkyl acryloyl monomer; and (f) a polyalkylene hydroxyl acryloyl monomer, wherein the method comprises the steps of: (i) providing a solution mixture of the alkaline earth metallic cross-linked carboxylic acryloyl monomer, the alkaline earth metallic cross-linked sulfonic acryloyl monomer, the amine acryloyl monomer, the hydroxyl acryloyl monomer, the alkyl acryloyl monomer, the polyalkylene hydroxyl acryloyl monomer, the stabilizing agent and a source of an alkaline earth metallic cross-linker; and (ii) polymerizing said solution mixture with an acid initiator to thereby synthesize said polymeric composition.

Claims

1. A polymeric composition comprising a plurality of monomers in the presence of a stabilizing agent, wherein said monomers comprise each of:
   a) an alkaline earth metallic cross-linked carboxylic acryloyl monomer;
   b) an alkaline earth metallic cross-linked sulfonic acryloyl monomer;
   c) an amine acryloyl monomer;
   d) a hydroxyl acryloyl monomer;
   e) an alkyl acryloyl monomer; and
   f) a polyalkylene hydroxyl acryloyl monomer.

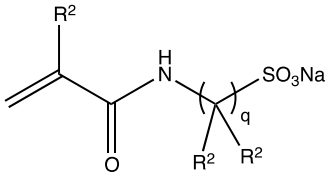
2. The polymeric composition according to claim 1, wherein said carboxylic acryloyl monomer is a compound of formula I:



(I)

wherein m is an integer from 1 to 16; and
R^1 is independently selected from the group consisting of hydrogen, alkyl and alkenyl.

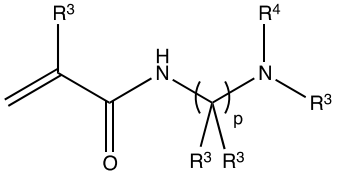
3. The polymeric composition according to claim 1 or 2, wherein said sulfonic acryloyl monomer is a compound of formula II:



(II)

wherein q is an integer of 1 to 16; and
R^2 is independently selected from the group consisting of hydrogen, alkyl and alkenyl.

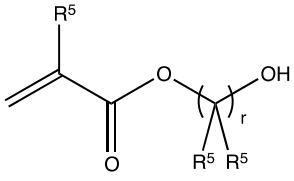
4. The polymeric composition according to any one of the preceding claims, wherein said amine acryloyl monomer is a compound of formula III:



(III)

wherein p is an integer of 1 to 12;
R^3 is independently selected from the group consisting of hydrogen, alkyl and alkenyl; and
R^4 is an alkyl.

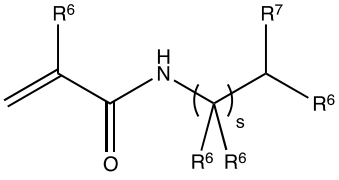
5. The polymeric composition according to any one of the preceding claims, wherein said hydroxyl acryloyl monomer is a compound of formula IV:



(IV)

wherein r is an integer of 1 to 12; and
R^5 is independently selected from the group consisting of hydrogen, alkyl and alkenyl.

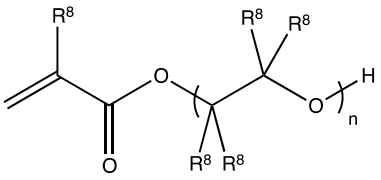
6. The polymeric composition according to any one of the preceding claims, wherein said alkyl acryloyl monomer is a compound of formula V:



(V)

wherein s is an integer of 0 to 6;
R^6 is independently selected from the group consisting of hydrogen, alkyl and alkenyl; and
R^7 is alkyl.

7. The polymeric composition according to any one of the preceding claims, wherein said polyalkylene hydroxyl acryloyl monomer is a compound of formula VI:



(VI)

wherein n is an integer of 2 to 100; and
R^8 is independently selected from the group consisting of hydrogen, alkyl and alkenyl.

8. The polymeric composition according to any one of the preceding claims, wherein said stabilizing agent is a zwitterionic monomer.

9. The polymeric composition according to claim 8, wherein said zwitterionic monomer is a protein-based acryloyl monomer.

10. The polymeric composition according to claim 9, wherein said protein-based acryloyl monomer is a peptide-based acryloyl monomer or
wherein said peptide-based acryloyl monomer is an amino acid-based acryloyl monomer or
wherein the amino acid of said amino acid-based acryloyl monomer is selected from the group consisting of a lysine, a glycine, a serine, a phenylalanine, a glutamic acid, an ornithine, an aspartic acid, a proline and a hydroxyproline groups or
wherein said lysine is selected from the group consisting of a *L*-lysine, a *D*-lysine and a *L*/*D*-lysine.

11. The polymeric composition according to any one of the preceding claims, wherein the metal of said alkaline earth metallic cross-linked carboxylic acryloyl monomer or said alkaline earth metallic cross-linked sulfonic acryloyl monomer is selected from the group consisting of beryllium, magnesium, calcium, strontium, barium and radium.

12. The polymeric composition according to any one of claims 1 to 11, wherein said polymeric composition is a hydrogel coating material.

13. A method for forming a polymeric composition comprising a plurality of monomers in the presence of a stabilizing agent, wherein said monomers comprise each of:
    a) an alkaline earth metallic cross-linked carboxylic acryloyl monomer;
    b) an alkaline earth metallic cross-linked sulfonic acryloyl monomer;
    c) an amine acryloyl monomer;
    d) a hydroxyl acryloyl monomer;
    e) an alkyl acryloyl monomer; and
    f) a polyalkylene hydroxyl acryloyl monomer,

    wherein the method comprises the steps of:

    i. providing a solution mixture of the alkaline earth metallic cross-linked carboxylic acryloyl monomer, the alkaline earth metallic cross-linked sulfonic acryloyl monomer, the amine acryloyl monomer, the hydroxyl acryloyl monomer, the alkyl acryloyl monomer, the polyalkylene hydroxyl acryloyl monomer, the stabilizing agent and a source of an alkaline earth metallic cross-linker; and
    ii. polymerizing said solution mixture with an acid initiator to thereby synthesize said polymeric composition.

14. The method according to claim 13, wherein said metallic cross-linker source is an alkaline earth metal salt selected from the group consisting of alkaline earth metal halide, alkaline earth metal nitrate, alkaline earth metal sulfate, alkaline earth metal citrate and alkaline earth metal oxalate or

    wherein said alkaline earth metal halide is selected from the group consisting of alkaline earth metal chloride, alkaline earth metal bromide and alkaline earth metal iodide or
    wherein said alkaline earth metal chloride is selected from the group consisting of beryllium chloride, magnesium chloride, calcium chloride, strontium chloride, barium chloride and radium chloride.

15. The method according to claim 13 or 14, wherein said acid initiator is an organic acid or an inorganic acid or

    wherein said organic acid is a glutaric acid selected from the group consisting of α-ketoglutaric acid and β-ketoglutaric acid.

16. The method according to any one of claims 13 to 15, wherein said solution mixture is provided in a solvent selected from an organic solvent or an aqueous solvent.

17. The method according to any one of claims 13 to 16, further comprising the step of providing said stabilizing agent at a concentration in the range of 0 to 100 mol% to said solution mixture.

18. The method according to any one of claims 13 to 17, wherein said polymerizing step is undertaken for a period of time in the range of 10 minutes to 60 minutes.

19. Use of the polymeric composition according to any one of claims 1 to 12 as an anti-fouling hydrogel coating material on materials.

20. The use of claim 19, wherein said material is a biomedical material.