CLAIMS

1. A formulation for forming a shape memory polymer, the formulation comprising:

an acrylate monomer;

a cross-linker for forming one or more cross-links with the acrylate monomer to form the shape memory polymer;

a photoinitiator for initializing the formation of the one or more cross-links upon exposure to ultraviolet light;

a photoabsorber for controlling a rate of formation of the one or more cross-links; and

one or more silicon oxide nanoparticles;

wherein a concentration of the photoabsorber is any one value selected from a range of 0.1 weight percent to 10 weight percent of the formulation;

wherein a concentration of the photoinitiator is any one value selected from a range of 1 weight percent to 10 weight percent of the formulation;

wherein a concentration of the cross-linker is any one value selected from a range of 5 weight percent to 50 weight percent of the formulation; and

wherein the acrylate monomer, the cross-linker, the photoinitiator, the photoabsorber, and the one or more silicon oxide nanoparticles are configured to form the shape memory polymer.

2. The formulation according to claim 1,

wherein acrylate monomer is tert-butyl acrylate monomer or tert-butyl methacrylate monomer.

3. The formulation according to claim 1 or claim 2,

wherein the cross-linker is a compound comprising two or more functional groups.

4. The formulation according to claim 3,

wherein the two or more functional groups are acrylates or methacrylates.

5. The formulation according to any one of claims 1 to 4,
wherein the cross-linker is di(ethylene glycol) diacrylate.

6. The formulation according to any one of claims 1 to 5,
wherein the photoinitiator is phenyl bis (2, 4, 6-trimethylbenzoyl) phosphine oxide (BAPO).

7. The formulation according to any one of claims 1 to 6,
wherein the photoabsorber is configured to absorb the ultraviolet light.

8. The formulation according to any one of claims 1 to 7,
wherein the photoabsorber is any one selected from a group consisting of 1-phenylazo-2-naphthol (Sudan I), 1-[4-(phenylazo)phenylazo]-2-naphthol (Sudan III), and $C_{28}H_{31}CIN_2O_3$ (Rhodamine B).

9. A method of forming a shape memory polymer, the method comprising:
mixing a formulation according to claim 1; and
exposing the mixture to the ultraviolet light so that the cross-linker forms one or more cross-links with the acrylate monomer to form the shape memory polymer;
wherein the formation of the one or more cross-links upon exposure to the ultraviolet light is initialized by the photoinitiator; and
wherein a rate of formation of the one or more cross-links is controlled by the photoabsorber.

10. The method according to claim 9,
wherein exposing the mixture to the ultraviolet light comprises using a laser scanning system to provide an ultraviolet laser beam to form the shape memory polymer.

11. The method according to claim 10,

wherein the ultraviolet laser beam is moved across the mixture at a speed of at least 700 mms^{-1}.

12. The method according to claim 10 or claim 11,

wherein the ultraviolet laser beam has a surface power density of a value in the range of 40 $mWcm^{-2}$ to 80 $mWcm^{-2}$.

13. The method according to claim 9,

wherein exposing the mixture to the ultraviolet light comprises using a projection system to project the ultraviolet light to form the shape memory polymer.

14. The method according to claim 13,

wherein the ultraviolet light is projected for a duration of any value less than 3 seconds.

15. The method according to claim 13 or claim 14,

wherein the projected ultraviolet light has a surface power density of a value in the range of 10 $mWcm^{-2}$ to 40 $mWcm^{-2}$.

16. The method according to any one of claims 9 to 15,

wherein the shape memory polymer formed has a thickness of 25 μm or less.

17. A shape memory polymer formed by a method of any one of claims 9 to 16.

18. The shape memory polymer according to claim 17,

wherein the shape memory polymer is configured to switch from a first shape to a second shape upon the shape memory polymer being heated to a temperature above a predetermined temperature; and

wherein the shape memory polymer is configured to switch from the second shape to the first shape upon application of an external stimulus.

19. The shape memory polymer according to claim 18,
wherein the predetermined temperature is any value selected from a range of 30 °C to 90 °C.

20. The shape memory polymer according to any one of claims 17 to 19,
wherein the one or more silicon oxide nanoparticles are chemically bonded to a polymer chain comprising the acrylate monomer and the cross-linker.

21. A device comprising a shape memory polymer according to any one of claims 17 to 20.

22. The device according to claim 21, wherein the device is any one of a suture, a stent, and a dental aligner.