Claims

1. A dissolvable microneedle patch, comprising:
a substrate portion comprising a first biocompatible material; and
a plurality of microneedle structures extending from the substrate portion, where each microneedle structure comprises:
a base portion comprising a second biocompatible material; and
a tip portion, wherein the tip portion comprises:
a nanoplex formed from a positively charged biopolymer that incorporates a cell targeting moiety and an siRNA; and
a third biocompatible material.

2. The dissolvable microneedle patch according to Claim 1, wherein the first biocompatible material is selected from one or more of the group consisting of hyaluronic acid, or other dissolvable and biocompatible polymers such as polysaccharides (chitosan, sodium alginate, dextran, and sodium chondroitin sulphate), cellulose derivatives (carboxymethyl cellulose, hydroxypropyl cellulose, and hydroxypropyl methylcellulose) and synthetic polymers (polyvinyl alcohol, polyvinylpyrrolidone, and methylvinylether-co-maleic anhydride).

3. The dissolvable microneedle patch according to Claim 1 or Claim 2, wherein the second biocompatible material is selected from one or more of the group consisting of hyaluronic acid, or other dissolvable and biocompatible polymers such as polysaccharides (chitosan, sodium alginate, dextran, and sodium chondroitin sulphate), cellulose derivatives (carboxymethyl cellulose, hydroxypropyl cellulose, and hydroxypropyl methylcellulose) and synthetic polymers (polyvinyl alcohol, polyvinylpyrrolidone, and methylvinylether-co-maleic anhydride).

4. The dissolvable microneedle patch according to any one of the preceding claims, wherein the first and the second biocompatible materials are the same biocompatible material.

5. The dissolvable microneedle patch according to any one of the preceding claims, wherein the third biocompatible material is selected from one or more of the group consisting of hyaluronic acid, or other dissolvable and biocompatible polymers such as polysaccharides (chitosan, sodium alginate, dextran, and sodium chondroitin sulphate), cellulose derivatives (carboxymethyl cellulose, hydroxypropyl cellulose, and hydroxypropyl methylcellulose) and synthetic polymers (polyvinyl alcohol, polyvinylpyrrolidone, and methylvinylether-co-maleic

anhydride), optionally wherein the third biocompatible material used to form the tip portion is hyaluronic acid.

6. The dissolvable microneedle patch according to any one of the preceding claims, wherein the first, second and third biocompatible materials are the same biocompatible material.

7. The dissolvable microneedle patch according to any one of the preceding claims, wherein the positively charged biopolymer is formed from:

a heterobifunctional polymer comprising a first set of functional groups that are positively charged and a second set of functional groups that are negatively charged in an aqueous environment; and

a molecule conjugated to the heterobifunctional polymer, where the molecule is conjugated by a functional group that forms a bond with the second set of functional groups of the heterobifunctional polymer, so as to reduce the number of the second functional groups in the second set of functional groups, thereby providing the positively charged biopolymer.

8. The dissolvable microneedle patch according to Claim 7, wherein the heterobifunctional polymer is selected from one or more of gelatin, collagen, silk fibroin, elastin and H_2N-PEG-CO_2H.

9. The dissolvable microneedle patch according to Claim 8, wherein the heterobifunctional polymer is gelatin.

10. The dissolvable microneedle patch according to any one of Claims 7 to 9, wherein the functional group in the molecule conjugated to the heterobifunctional polymer that forms a bond with the second set of functional groups of the heterobifunctional polymer is selected from one or more of amide, amino, and ammonium.

11. The dissolvable microneedle patch according to any one of Claims 7 to 9, wherein the molecule conjugated to the heterobifunctional polymer is selected from one or more of 4-hydroxybenzylamine, dopamine, and tyramine (e.g. tyramine).

12. The dissolvable microneedle patch according to any one of the preceding claims, wherein the cell targeting moiety is selected from one or more of gelatin, transferrin, cyclic-

Arginine-Glycine-Aspartic acid (RGD) tripeptide, skin protein-derived peptides (e.g. one or more of the group consisting of KTTKS, NAP-amide, and Lam332), and folic acid.

13. The dissolvable microneedle patch according to any one of the preceding claims, wherein the siRNA is selected from one or more of the group consisting of:

(a) siTGFβ1-337: 5′-GGUGGAAACCCACAACGAATT-3′;
(b) siFAK: 5’-GCGAAATCCA-TAGCAGGCCACTATAGTGAGTCGTATTACC-3’;
(c) siSphk2: 5′-CAGGATTGCGCTCGCTTTCAT-3′;
(d) siRunx2: 5′-CAGAAGAATGGTACAAATCCAAG-3′;
(e) sieIF3a: 5′-GCAGATGGTCTTAGATATA-3′;
(f) siEDB: 5′-AAGGTATCCCTATTTTTGAAGCCTGTCTC-3’;
(g) siRe1A: 5′-GGU GCA GAA AGA CAU UdTdT-3′;
(h) siIL-10: 5’-UUUAGCUACUACCGCAGCGdTdT-3’;
(i) siGPNMB: 5′-GCACGGGUUUCUAUAAACAdTdT-3′;
(j) siSPARC: 5’-AACAAGACCUUCGACUCUUCC-3’.

14. The dissolvable microneedle patch according to Claim 13, wherein the siRNA is siSPARC: 5’-AACAAGACCUUCGACUCUUCC-3’.

15. The dissolvable microneedle patch according to any one of the preceding claims, wherein the plurality of microneedle structures extending from the substrate portion have a height of from 100 μm to 2.5 mm, such as from 200 μm to 1.5 mm, such as from 300 μm to 500 μm.

16. A dissolvable microneedle patch according to any one of Claims 1 to 15 for use in medicine, comprising a therapeutically effective siRNA for treating skin indications and diseases.

17. Use of a dissolvable microneedle patch according to any one of Claims 1 to 15 for the manufacture of a medicament for the treatment of a skin condition or disorder, wherein the microneedle patch comprises a therapeutically effective siRNA for treating skin indications and diseases.

18. The use according to Claim 17, wherein the skin condition or disorder is selected from one or more of the group consisting of scarring (e.g. hypertrophic scarring), keloid formation, eczema, and hyperpigmentation.

19. The use according to Claim 18, wherein the skin condition or disorder is hypertrophic scarring.

20. The use according to Claim 19, wherein the dissolvable microneedle patch is to be applied to the skin after wound union has occurred.

21. The use according to according to claim 18, wherein the dissolvable microneedle patch is to be applied to the skin about two weeks after the wound was created.