Claims

1. A two-dimensional (2D) graphene oxide-thermoresponsive polymer composite film comprising:

- at least two graphene oxide (GO) layers; and
- a thermoresponsive polymer layer between each GO layer,

wherein the thermoresponsive polymer layer comprises cellulose derivatives, and wherein the thermoresponsive polymer layer switches between being aligned and being disoriented between the at least two GO layers when temperature of the composite film changes from being below lower critical solution temperature (LCST) of the thermoresponsive polymer comprised in the composite film to being above the LCST of the thermoresponsive polymer.

2. The composite film according to claim 1, wherein the thermoresponsive polymer comprised in the thermoresponsive polymer layer is hydrophobic when the thermoresponsive polymer layer is aligned between the at least two GO layers and wherein the thermoresponsive polymer comprised in the thermoresponsive polymer layer is hydrophilic when the thermoresponsive polymer layer is disoriented between the at least two GO layers.

3. The composite film according to claim 1 or 2, wherein the composite film is formed by self-assembly of the at least two GO layers and the thermoresponsive polymer layer.

4. The composite film according to any preceding claim, wherein each GO layer of the at least two GO layers and the thermoresponsive polymer layer are bonded to one another via electrostatic interactions, hydrogen bonds, van der Waals interaction, hydrophobic interactions, or a combination thereof.

5. The composite film according to any preceding claim, wherein the composite film comprises the at least two GO layers in a layer-by-layer assembly.

6. The composite film according to any preceding claim, wherein the composite film has an average thickness of 10 nm-100 μm.

7. The composite film according to claim 6, wherein the composite film has an average thickness of 2-100 μm.

8. The composite film according to any preceding claim, wherein the composite film is a free-standing composite film.

9. The composite film according to any preceding claim, wherein water flux through the composite film is controlled by changes in orientation of thermoresponsive polymer layer between the at least two GO layers.

10. The composite film according to any preceding claim, wherein the composite film further comprises reduced GO (rGO).

11. A method of preparing the composite film according to any preceding claim, the method comprising:

- mixing a first solution comprising GO and a second solution comprising a thermoresponsive polymer to form a mixture; and
- vacuum filtering the mixture onto a substrate to form the composite film.

12. The method according to claim 11, wherein the vacuum filtering enables the formation of the composite film by self-assembly of GO layers and thermoresponsive polymer layers.

13. The method according to claim 11 or 12, wherein the method further comprises drying the composite film following the vacuum filtering.

14. The method according to any of claims 11 to 13, wherein the method further comprises reducing the GO layers to form reduced GO layers.

15. The method according to claim 14, wherein the reducing the GO layers comprises adding a reducing agent to at least a part of the composite film.