CLAIMS

1. A biocompatible composite comprising:

a semiconducting polymer having an electrically conductive domain and an electrically insulating domain coupled to the electrically conductive domain; and

a biocompatible ionic liquid doped in the semiconducting polymer,

wherein the biocompatible ionic liquid renders a portion of the electrically insulating domain distal from the electrically conductive domain to expose a portion of the electrically conductive domain, and

wherein the semiconducting polymer comprises poly-3,4-ethylenedioxythiophene:poly-4-styrenesulfonate and the ionic liquid comprises tris(2-hydroxyethyl)methylammonium methylsulfate.

2. The composite of claim 1, wherein the biocompatible ionic liquid and the semiconducting polymer have a weight ratio ranging from 1:100 to 10:1.

3. A method of forming the biocompatible composite of claim 1 or 2, the method comprising:

providing a semiconducting polymer having an electrically conductive domain and an electrically insulating domain coupled to the electrically conductive domain;

forming an aqueous solution comprising the biocompatible ionic liquid; and

mixing the semiconducting polymer and the aqueous solution.

4. The method of claim 3, wherein forming the aqueous solution comprising the biocompatible ionic liquid comprises diluting or dissolving the biocompatible ionic liquid in an aqueous medium.

5. The method of claim 3 or 4, wherein mixing the semiconducting polymer and the aqueous solution is carried out for at least 10 minutes.

6. The method of any one of claims 3 to 5, further comprising adding an organosilane to:

the semiconducting polymer; or

during or after mixing the semiconducting polymer and the aqueous solution.

7. The method of claim 6, wherein (i) mixing the organosilane with the semiconducting polymer is carried out for at least 10 mins or (ii) mixing the semiconducting polymer and the aqueous solution in the presence of the organosilane is carried out for at least 10 mins.

8. An organic electrochemical transistor comprising:

a source electrode and a drain electrode; and

the biocompatible composite of claim 1 or 2 configured as an active layer between and in contact with both the source electrode and the drain electrode.

9. The organic electrochemical transistor of claim 8, further comprising an electrolyte arranged in contact with the active layer.

10. The organic electrochemical transistor of claim 8 or 9, wherein the source electrode and the drain electrode are configured on a substrate.

11. The organic electrochemical transistor of claim 10,

wherein the substrate is derived from a flexible or rigid material,

wherein the flexible material comprises polyimide, polyethylene terephthalate, parylene C, polydimethylsiloxane, cellulose, polyacrylonitrile, polylactic acid, or a derivative thereof, or a combination thereof, and

wherein the rigid material comprises silicon oxide, glass, quartz, metal foil, polymers, or a derivative thereof, or a combination thereof.

12. The organic electrochemical transistor of any one of claims 8 to 11, further comprising a gate electrode arranged in contact with the electrolyte.

13. A method of forming the organic electrochemical transistor of any one of claims 8 to 12, the method comprising:

providing a substrate;

forming a source electrode and a drain electrode on the substrate;

forming a channel between the source electrode and the drain electrode after forming the source electrode and the drain electrode for subsequent formation of an active layer;

forming a first insulating layer and a second insulating layer on the first insulating layer to cover portions of the source electrode and the drain electrode not covered by the active layer;

forming the biocompatible composite of claim 1 or 2 as the active layer between and in contact with both the source electrode and the drain electrode; and

removing the second insulating layer and retaining a first insulating layer to cover portions of the source electrode and the drain electrode not covered by the active layer.

14. The method of claim 13, wherein forming the channel comprises:

depositing the first insulating layer on the substrate over the source electrode and the drain electrode;

treating the substrate having the first insulating layer with a soap solution;

depositing a second insulating layer on the first insulating layer;

depositing a photoresist on the second insulating layer;

developing the photoresist to form a patterned photoresist layer; and

etching the second insulating layer and the first insulating layer with the patterned photoresist layer to form the channel for subsequent formation of the active layer.

15. The method of claim 13 or 14, wherein forming the biocompatible composite as the active layer comprises:

depositing the biocompatible composite in the channel;

annealing the substrate having the biocompatible composite thereon;

tearing off the second insulating layer;

rinsing the substrate having the biocompatible composite thereon; and

drying the substrate having the biocompatible composite therein with an inert gas.

16. The method of any one of claims 13 to 15, further comprising arranging an electrolyte on the active layer, wherein the electrolyte is in contact with the active layer.

17. The method of claim 16, further comprising forming a gate electrode in contact with the electrolyte.

18. A wearable device operable as a pressure sensor, the wearable device having a sensing component comprising:

at least two electrodes configured on a substrate; and

the biocompatible composite of claim 1 or 2 configured as a sensing layer on and in contact with the at least two electrodes.

19. The wearable device of claim 18, wherein the sensing component comprises a flexible polymer layer having protruding structures configured to face the electrodes.

20. The wearable device of claim 19, wherein the biocompatible composite is a layer formed at a surface of the flexible polymer layer which the protruding structures reside.

21. A method of forming the wearable device of any one of claims 18 to 20, the method comprising:

providing a substrate having at least two electrodes;

forming a sensing component comprising the biocompatible composite of claim 1 or 2 configured as a sensing layer on and in contact with the at least two electrodes; and

integrating the sensing component with an organic electrochemical transistor of any one of claims 8 to 12.

22. The method of claim 21, wherein forming the sensing component comprises:

forming a flexible polymer layer having protruding structures from a mold; and

forming the biocompatible composite as a layer at a surface of the flexible polymer layer which the protruding structures reside.

23. An electrocardiogram recording device comprising:

an organic electrochemical transistor of any one of claims 8 to 12; and

two or more testing electrodes attachable to a human skin surface,

wherein at least one of the two or more testing electrodes is connected to a gate electrode of the organic electrochemical transistor and at least another of the two or more testing electrodes is connected to a source electrode of the organic electrochemical transistor.

24. The electrocardiogram recording device of claim 23, wherein the organic electrochemical transistor is attachable to the human skin surface or placed at a probe-able position distal from the heart.

25. The electrocardiogram recording device of claim 23 or 24, wherein one of the two or more testing electrodes connected to the gate electrode is attached to the human skin surface proximal to the heart and in contact with the gate electrode.

26. The electrocardiogram recording device of any one of claims 23 to 25, wherein the at least another of the two or more testing electrodes connected to the source electrode is attachable to the human skin surface which is distal from the heart and in contact with the source electrode.

27. The electrocardiogram recording device of any one of claims 23 to 26, wherein each of the two or more testing electrodes comprises silver, a silver–based material, an electrode gel, a metal, a metal-based material, carbon, a carbon-based

material, a conductive polymer, a conductive hydrogel, or a derivative thereof, or a combination thereof.