CLAIMS

CLAIMS:

1. A method for fabricating electrodes for a microchannel device having a membrane, the method comprising:

forming a first electrically conductive film layer on a portion of an upper surface of a first material substrate;

attaching a first polymeric layer defining the dimensions of the microfluidic channel to the upper surface of the first material substrate to form a first opened microchannel containing the first electrically conductive film layer, the first electrically conductive film layer extending across the first opened microchannel;

forming a second electrically conductive film layer on a portion of a lower surface of a second material substrate;

attaching a second polymeric layer defining the dimensions of the microfluidic channel to the lower surface of the second material substrate to form a second opened microchannel, the second electrically conductive film layer extending across the second opened microchannel; and

attaching the first opened microchannel containing the first electrically conductive film layer to a bottom side of the membrane and the second opened microchannel containing the second electrically conductive film layer to the top side of the membrane, the first electrically conductive film layer and the second electrically conductive film layer each constituting electrodes and being positioned with the membrane therebetween, wherein at least one of the electrodes is transparent to light.

2. The method of claim 1, wherein the first electrically conductive film layer, the first material substrate, and the first polymeric layer defining the dimensions of the microfluidic channel form a first microchannel assembly, the second electrically conductive film, the second material substrate, and the second polymeric layer defining the dimensions of the microfluidic channel form a second microchannel assembly, the first microchannel assembly and the second microchannel assembly being symmetrical.

3. The method of claim 1, further comprising integrating a plurality of electrical contacts into the first material substrate and the second material substrate and/or the membrane, each of

the plurality of electrical contacts being electrically coupled with a respective end of the first electrically conductive film layer and the second electrically conductive film layer.

4. The method of claim 3, further comprising integrating a connection to the plurality of electrical contacts for enabling connecting the electrodes to external electronics and instrumentation.

5. The method of claim 1, wherein the material substrate is a polymer, including polycarbonate, styrene-ethylene/butylene-styrene (SEBS), polydimethylsiloxane, polyurethane, polyester, cyclic olefin copolymer (COC), cyclic olefin polymer (COP), SU-8, polymethylmethacrylate (PMMA), polyvinyl chloride (PVC), polystyrene (PS), and/or polyethylene terephthalate (PET).

6. The method of claim 1, wherein the material substrate is glass, silicon, and/or silicon nitride.

7. The method of claim 1, wherein the membrane is a polymer, including polycarbonate, styrene-ethylene/butylene-styrene (SEBS), polydimethylsiloxane, polyurethane, polyester, cyclic olefin copolymer (COC), cyclic olefin polymer (COP), silicon nitride, SU-8, polymethylmethacrylate (PMMA), polyvinyl chloride (PVC), polystyrene (PS), and/or polyethylene terephthalate (PET).

8. The method of claim 1, wherein at least one of the first first electrically conductive film and the second first electrically conductive film consists of a plurality of layers including one or more titanium layers and at least one gold layer.

9. The method of claim 8, wherein the plurality of layers includes a first titanium layer having a thickness of about 3 nanometers, a second gold layer having a thickness of about 25 nanometers, and a third titanium layer having a thickness of about 1 nanometers.

10. The method of claim 1, wherein the electrodes include a material selected from a group consisting of a metal, a semi-conductor, an oxide, a carbon, and a polymer.

11. The method of claim 10, wherein the metal includes a material selected from a group consisting of gold, platinum, silver, and silver chloride.

12. A method for fabricating electrodes for a microchannel device having a membrane, the method comprising:

forming a first electrically conductive film layer on a portion of an upper surface of a first material substrate;

attaching a first polymeric layer defining the dimensions of the microfluidic channel to the upper surface of the first material substrate to form a first opened microchannel containing the first electrically conductive film layer, the first electrically conductive film layer extending across the first opened microchannel;

forming a second electrically conductive film layer on a portion of a lower surface of a second material substrate;

attaching a second polymeric layer defining the dimensions of the microfluidic channel to the lower surface of the second material substrate to form a second opened microchannel, the second electrically conductive film layer extending across the second opened microchannel; and

attaching the first opened microchannel containing the first electrically conductive film layer to a bottom side of the membrane and the second opened microchannel containing the second electrically conductive film layer to the top side of the membrane, the first electrically conductive film layer and the second electrically conductive film layer each constituting electrodes and being positioned with the membrane therebetween, wherein at least one of the electrodes has a thickness such that it is transparent to light.

13. A device containing electrodes, the device comprising:

a body having a first microchannel and a second microchannel;

a membrane located at an interface region between the first microchannel and the second microchannel, the membrane including a first side facing toward the first microchannel and a

second side facing toward the second microchannel, the first side having cells adhered thereto; and

a first electrode positioned on a first side of the membrane and a second electrode positioned on a second side of the membrane, wherein at least one of the electrodes is transparent to light.

14. The device of claim 13, wherein the first electrode is symmetrically integrated with respect to the second electrode.

15. The device of claim 13, further comprising electrical contacts directly integrated in one or more of the body and the membrane such that each is electrically coupled with a respective end of the first and second electrodes.

16. The device of claim 13, wherein at least one of the body, the membrane, and the electrodes includes at least one material selected from a group consisting of a flexible material and a stretchable material.

17. The device of claim 13, wherein at least one of the first electrode and the second electrode has a thickness in the range of approximately 10-30 nanometers.

18. The device of claim 13, wherein at least one of the first electrode and the second electrode consists of a plurality of layers including one or more titanium layers and at least one gold layer.

19. The device of claim 13, wherein at least one of the first electrode and the second electrode is transparent to light.

20. A device containing electrodes, the device comprising:

a body having a first microchannel and a second microchannel;

a membrane located at an interface region between the first microchannel and the second microchannel, the membrane including a first side facing toward the first microchannel and a

second side facing toward the second microchannel, the first side having cells adhered thereto; and

a first electrode positioned on a first side of the membrane and a second electrode positioned on a second side of the membrane, wherein at least one of the first electrode and the second electrode has a thickness such that it is transparent to light.

21. A method of measuring electrical characteristics across a membrane, comprising:

(a) providing a microfluidic device having

i) a first microfluidic channel,

ii) a second microfluidic channel,

iii) a semipermeable membrane disposed between the first microfluidic channel and the second microfluidic channel, the semipermeable membrane comprising first and second surfaces,

iv) a first culture of cells on the first surface of the semipermeable membrane, and a second culture of cells on the second surface of the semipermeable membrane, and

v) a first electrode in fluid communication with the first microfluidic channel and a second electrode in fluid communication with the second microfluidic channel, wherein the first and second electrodes are transparent; and

(b) measuring electrical characteristics across the semipermeable membrane using the first and second electrodes.

22. The method of claim 21, further comprising (c) observing the cells through either the first or second transparent electrodes.

23. The method of claim 21, wherein the first and second electrodes include gold having a thickness such that it is transparent to light.

24. The method of claim 21, wherein the thickness of the gold is 25 nanometers or less.

25. The method of claim 21, wherein the first culture of cells includes epithelial cells and the measuring includes measuring transepithelial electric resistance (TEER).

26. A method of measuring electrical characteristics across a membrane, comprising:

a) providing a microfluidic device including

i) a first microfluidic channel,

ii) a second microfluidic channel,

iii) a semipermeable membrane disposed between the first microfluidic channel and the second microfluidic channel,

iv) a first culture of cells in the first microfluidic channel, and

v) electrodes in fluid communication with the first microfluidic channel; and

b) measuring electrical characteristics across the membrane by impedance spectroscopy.

27. The method of claim 26, wherein the membrane includes first and second surfaces, the first culture of cells being on the first surface of the semipermeable membrane.

28. The method of claim 27, wherein the microfluidic device further includes a second culture of cells on the second surface of the semipermeable membrane.

29. A device comprising: a membrane positioned between a top electrode and a bottom electrode, the top and bottom electrodes being connected to a detachable interface.

30. The device of claim 29, wherein the device is a microfluidic device and the membrane is positioned between first and second microchannels.

31. The device of claim 29, wherein the microfluidic device includes cells in the first or second microchannels, or both.