

BONDING ELECTRONIC COMPONENTS TO PATTERNED NANOWIRE TRANSPARENT CONDUCTORS

BACKGROUND

[0001] Transparent conductors are utilized on touch screens to enable human touch or gesture interactions with computers, smart phones, and other graphics based screen interfaces.

Nanowires are one material suitable for making the transparent conductors. For example, PCT publication WO 2007/022226, entitled “Nanowire-Based Transparent Conductors” discloses a nanowire material sold by Cambrios Technologies Corporation that can be patterned into a suitable grid to enable the production of touch screens for use with computers.

[0002] 3M File No. 69879US003 describes a process for efficient production of touch screen devices in which a conductive material is patterned (e.g., printed) into electrical traces on a substrate. This process can be performed in a roll-to-roll process where the substrate is unwound, converting operations such as printing and drying/curing are performed, and then the patterned substrate is wound again into a roll for further transport and processing.

SUMMARY

[0003] The patterned conductive material formed by the processes described in 3M File No. 69879 can be connected to an electronic circuit component to produce an electronic assembly such as, for example, a touch sensor for use in a touch-screen display. The present disclosure is directed to processes for connecting the patterned conductive layers formed by the processes described in 3M File No. 69879US003 to electronic circuit components such as, for example, flexible circuits, to form an electronic assembly that can be used as a component of an electronic device. The present disclosure is further directed to electronic devices such as, for example, touch-screen displays, constructed using these interconnection processes.

[0004] In one embodiment, the present disclosure is directed to a method for making an electronic assembly includes applying a conductive adhesive to a patterned resist layer overlying a patterned conductive nanowire layer on a substrate and engaging an electrical contact of

an electronic component with the conductive adhesive to provide an electrical connection between the electronic component and the conductive nanowire layer. The patterned conductive nanowire layer on the substrate is formed by coating a substrate with a conductive layer comprising nanowires; applying a pattern on the conductive layer with a resist matrix material to generate on the substrate one or more first regions of exposed conductive layer and one or more second regions of resist matrix material; hardening or curing the resist matrix material; over coating the pattern with a strippable polymer layer; hardening or curing the strippable polymer layer; and peeling the strippable polymer layer from the substrate to remove the exposed conductive layer from the substrate in the one or more first regions of the substrate to form the patterned conductive layer on the substrate, wherein at least some of the nanowires extend above the resist matrix material and provide for electrical interconnection with the conductive nanowire layer.

[0005] In another embodiment, the present disclosure is directed to a flexible electronic circuit including a flexible substrate having thereon a pattern of conductive nanowires, wherein the conductive nanowires are overlain by a layer of a resist matrix material; a conductive adhesive on the layer of resist matrix material; and an electrical contact of an electronic component in contact with the conductive adhesive.

[0006] In yet another embodiment, a touch screen display includes a liquid crystal display and an electronic assembly. The electronic assembly includes a glass substrate on the liquid crystal display, wherein the glass substrate has thereon a pattern of conductive nanowires. The conductive nanowires are overlain by a layer of a resist matrix material. A conductive adhesive resides on the layer of resist matrix material; and an electrical contact of a flexible circuit is in contact with the conductive adhesive. A flexible transparent surface overlies the electronic assembly.

[0007] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

[0008] FIG. 1 is a schematic, cross-sectional view of a conductive nanowire layer on a substrate, wherein the conductive nanowire layer is overlain by a patterned resist matrix material.

[0009] FIG. 2 is a schematic, cross-sectional view of the construction of FIG. 1 overlain by a strippable polymer layer.

[0010] FIG. 3 is a schematic, cross-sectional view of the construction of FIG. 2 following removal of the strippable polymer layer.

[0011] FIG. 3A is a schematic, cross-sectional view of a portion of the conductive nanowire layer following removal of the strippable polymer layer, and illustrating protruding nanowires.

CLAIMS:

1. A method for making an electronic assembly, comprising:

applying a conductive adhesive to a patterned resist layer overlying a patterned
5 conductive nanowire layer on a substrate, wherein the patterned conductive nanowire layer on
the substrate is formed by:

coating a substrate with a conductive layer comprising nanowires;

applying a pattern on the conductive layer with a resist matrix material to generate
on the substrate one or more first regions of exposed conductive layer and one or more
10 second regions of resist matrix material;

hardening or curing the resist matrix material;

over coating the pattern with a strippable polymer layer;

hardening or curing the strippable polymer layer; and

peeling the strippable polymer layer from the substrate to remove the exposed
15 conductive layer from the substrate in the one or more first regions of the substrate to
form the patterned conductive layer on the substrate, wherein at least some of the
nanowires extend above the resist matrix material and provide for electrical
interconnection with the conductive nanowire layer; and

engaging an electrical contact of an electronic component with the conductive adhesive
20 to provide an electrical connection between the electronic component and the conductive
nanowire layer.

2. The method of claim 1, wherein the conductive adhesive comprises a layer of an adhesive
with metal particles therein.

3. The method of claim 2, wherein the metal particles are selected from silver, gold, copper,
aluminum, and combinations thereof.

4. The method of claim 2 or 3, wherein the conductive adhesive comprises an acrylic
30 pressure sensitive adhesive, a thermally bonded adhesive, or combinations thereof.

5. The method of any of claims 1-4, wherein the resist layer has a thickness of about 10
nanometers to about 300 nanometers.

6. The method of any of claims 1-4, wherein the resist layer has a thickness of about 40 nanometers to about 200 nanometers.
- 5 7. The method of any of claims 1-6, wherein the resist layer has a refractive index of about 1.30 to about 2.50.
8. The method of any of claim 1-7, wherein the conductive adhesive comprises a tape.

9. The method of claim 1, wherein the conductive adhesive is applied by:

5 applying a first side of a transfer tape to the resist layer overlying the patterned
conductive nanowire layer on the substrate, wherein the first side of the transfer tape comprises a
first conductive adhesive layer comprising an adhesive matrix comprising metal particles,
wherein the adhesive matrix comprises a pressure sensitive adhesive, a thermally bonded
adhesive or combinations thereof, and wherein the metal particles contact nanowires protruding
10 from the resist layer;

engaging a metal contact of the electronic component with a second conductive adhesive layer on a second side of the transfer tape opposite the first side to provide an electrical connection between the electronic component and the conductive nanowire layer.

5 10. A flexible electronic circuit, comprising:
 a flexible substrate comprising thereon a pattern of conductive nanowires, wherein the
 conductive nanowires are overlain by a layer of a resist matrix material;
 a conductive adhesive on the layer of resist matrix material; and
 an electrical contact of an electronic component in contact with the conductive adhesive.

10 11. The flexible electronic circuit of claim 10, wherein the resist matrix material has a
 thickness of about 10 nanometers to about 300 nanometers.

15 12. The flexible electronic circuit of claim 10, wherein the resist matrix material has a
 thickness of about 40 nanometers to about 200 nanometers.

20 13. The flexible electronic circuit of any of claims 10-12, wherein the conductive adhesive
 comprises a transfer tape, and wherein the transfer tape comprises a first side having thereon a
 first conductive adhesive layer contacting the layer of resist matrix material, and a second side
 opposite the first side, wherein the second side comprises a second conductive adhesive layer
 contacting the electrical contact of the electronic component.

25 14. The flexible electronic circuit of claim 13, wherein the first conductive adhesive layer
 comprises a matrix of an adhesive comprising metal particles, wherein the adhesive comprises a
 pressure sensitive adhesive, a thermally bonded adhesive and combinations thereof, and wherein
 the metal particles in the first conductive adhesive layer contact nanowires protruding from the
 conductive pattern and the resist matrix material.

30 15. The flexible electronic circuit of claim 14, wherein the metal particles comprise silver,
 gold, copper, aluminum and combinations thereof.

16. The flexible electronic circuit of any of claims 10-15, wherein the electronic component comprises a flexible circuit.

17. A flexible electronic circuit made according to the process of any of claims 1-8.

18. A touch screen display comprising:
a liquid crystal display;
an electronic assembly comprising:

a glass substrate on the liquid crystal display, wherein the glass substrate
comprises thereon a pattern of conductive nanowires, wherein the conductive nanowires are
overlain by a layer of a resist matrix material;

a conductive adhesive on the layer of resist matrix material; and

an electrical contact of a flexible circuit in contact with the conductive adhesive;

and

a flexible transparent surface overlying the electronic assembly.

19. The display of claim 18, wherein the conductive adhesive layer comprises a matrix of an
adhesive loaded with metal particles, wherein the adhesive comprises a pressure sensitive
adhesive, a thermally bonded adhesive, and combinations thereof, and wherein the metal
particles in the first conductive adhesive layer contact nanowires protruding from the conductive
pattern and into the resist matrix material.

20. The display of any of claims 18-19, wherein the resist matrix material has a thickness of
about 10 nanometers to about 300 nanometers