TOUCH SENSOR AND METHOD OF MAKING

BACKGROUND

[0001] Resistive touch sensors have found wide application as input devices for computers, personal digital assistants and a variety of display devices that can make use of touch or writing input. A typical resistive touch screen mounts in front of a display device such as a cathode ray tube (CRT) or liquid crystal display (LCD), and couples to an electronic controller. The touch screen includes a flexible topsheet and a rigid substrate with transparent resistive coatings on their facing surfaces. A separation is maintained between the resistive coatings of the topsheet and substrate by a peripheral spacer. A matrix of spacer dots is provided on the resistive coating of the substrate to help prevent spurious contact between the resistive coatings that would result in an unintended touch input. The diameter, height, and spacing of the spacer dots determines the activation force of the sensor, the activation force being the amount of force from a touch implement required to bring the resistive coatings into contact so that a touch input can be registered.

SUMMARY OF THE INVENTION

[0002] The present invention provides a touch sensor that includes a first layer that is movable toward a second layer in response to a touch in the touch-sensitive area of the sensor. As a result of the first layer being moved toward the second layer, a signal is produced that can be detected to determine the location of the touch. A plurality of spacers are disposed in the touch-sensitive area between the first and second layers, and the spacers are bonded to both the first layer and the second layer.

[0003] The present invention also provides a method of making a touch sensor. The method includes configuring a first layer and a second layer with a gap between them, disposing a plurality of spacers in a touch-sensitive area between the first and second layers, and bonding the spacers to both the first layer and the second layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The invention may be more completely understood in consideration of the following detailed description of various embodiments of the invention in connection with the accompanying drawings, in which:

[0005] **FIG. 1** is a schematic side view of a touch sensor including double-bonded spacers;

[0006] **FIG. 2** is a three-dimensional schematic exploded view of a 4-wire resistive touch sensor;

[0007] **FIG. 3** is a partial schematic side view of a resistive touch sensor;

[0008] **FIG. 4** is a partial schematic side view of a resistive touch sensor having double-bonded spacers in accordance with the present invention;

[0009] **FIG. 5** is a three-dimensional schematic exploded view of a 4-wire resistive touch sensor having single-bonded and double-bonded spacers;

[0010] FIGS. **6**A-C depict steps in a method of forming a resistive touch sensor using a double bonding technique of the present invention;

[0011] FIGS. **7**A-C depict steps in a method of forming a touch sensor using a double bonding technique of the present invention; and

[0012] **FIG. 8** is a schematic representation of a display system that includes a touch sensor.

[0013] While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention.

DETAILED DESCRIPTION

[0014] In conventional resistive touch sensor constructions, a flexible topsheet, which provides the touch surface, is generally attached to a rigid substrate along its edges via a peripheral sealing spacer, and the topsheet is drawn taut in an attempt to maintain a uniform gap. The need to keep the topsheet flat and tight requires that a significant amount of the border area be dedicated to the peripheral spacer for this attachment function. Since the topsheet can slide freely over the tops of the spacer dots, it can sag down, bubble up, or stretch with use or as environmental conditions change. This type of wear to the topsheet can be visually displeasing, interfere with normal operation, cause shorting of the resistive coatings, and produce unwanted, annoying optical artifacts such as Newton's rings. Repeated topsheet contact against the spacer dots can also damage or dislodge the spacer dots.

[0015] A more robust yet flexible resistive touch sensor with a more uniform and enduring gap less subject to buckling, bubbling, and sagging and without the attendant erroneous signals and annoying artifacts can be achieved by attaching the spacer dots in the gap to both the substrate and the topsheet. Such double bonding of the spacer dots can greatly reduce slipping of the topsheet so that any sagging, bubbling or buckling occurs only locally, for example in areas between double-bonded spacer dots. As such, the topsheet can be better controlled to avoid erroneous signals and annoying visual effects.

[0016] While the present invention is well-suited for use in resistive touch screen constructions, the present invention applies to any touch sensor having a construction that includes a first layer (such as a flexible topsheet) that is movable toward a second layer (such as a rigid substrate) in response to a sufficient touch input on the touch surface. Local deformation of the first layer in response to the touch brings the first and second layers into close enough proximity that a signal can be detected from which the touch location can be determined. Touch sensors that detect a signal upon physical contact of two resistive layers are called resistive touch sensors. Other touch sensors can detect signals resulting from the local change in separation between the first and second layers, for example a change in capacitance between two resistive layers when one is brought locally into closer proximity. Examples of such touch sensors are disclosed in co-owned U.S. patent application Ser. No. 10/183,876, as well as in U.S. Pat. Nos. 5,686,705 and 6,002,389, the disclosures of which documents are wholly incorporated into this document.