can also be formed by embossing or micromolding techniques whereby the spacers are embossed or molded directly onto a resistive layer of the touch sensor. Alternatively, spacer structures may be formed separately as particles or fibers, for example, that can be distributed over a resistive layer of the sensor. In such a case, an adhesive material may be pre-printed or otherwise disposed in selected areas on a resistive layer of the touch sensor so that the distributed spacers can adhere to those selected areas, thereby fixing their positions. Alternatively, spacer particles may be adhesive, for example particles having an adhesive coating. Exemplary spacers may be approximately 1 to 100 microns in diameter or width, 0.5 to 50 microns in height, and spaced apart approximately 1 cm or less, for example. While all the spacers are typically spaced apart an average of 1 cm or less from neighboring spacers, it should be noted that the distance between neighboring double-bonded spacers may be much larger, for example as shown in **FIG. 5**.

[0026] For comparison, **FIG. 3** shows a conventional resistive touch sensor **10***a* that includes a topsheet **12***a* having a resistive layer **16***a,* a substrate **14***a* having a resistive layer **18***a,* a peripheral spacer **26** setting the gap and sealing between the topsheet and the substrate, and a plurality of spacer dots **24***a* adhered to the resistive coating **18***a* of the substrate. Topsheet **12***a* floats above spacer dots **24***a,* and there may be a small gap between the top of each spacer dot **24***a* and the neighboring resistive coating **16***a.* This allows the top sheet to slip with respect to the substrate **14***a.* While topsheet **12***a* may at times make contact with some spacer dots **24***a,* even in the absence of a touch input, the spacer dots **24***a* are not bonded to the topsheet resistive layer **16***a.* Any differential forces placed on the topsheet may be propagated across the entire length and breadth of the topsheet, allowing large scale buckling, bubbling, or sagging across many rows and columns of spacer dots.

[0027] **FIG. 4** shows a resistive touch sensor **10***b* in accordance with the present invention where the spacers **24***b* are bonded to both the resistive coating **18***b* on substrate **14***b* and the resistive coating **16***b* on topsheet **12***b.* In this way, it is possible to obtain a more rugged and robust touch sensor where the expansion, contraction or other movement or reconfiguration of topsheet **12***b* is contained within local areas between double bonded spacer dots **24***b.* A peripheral seal **26***b* may still be included.

[0028] In some embodiments, it may be desirable to bond all spacers to both resistive layers of the touch sensor. In other embodiments, it may be desirable to bond only a portion of the spacers to both the topsheet and substrate, while the other spacers are bonded to only one of the topsheet and substrate. For example, double bonding all spacers may result in an undesirably high activation force for the sensor, especially when the spacing between spacers is relatively small or the height of the spacers is relatively large. In these instances, it may be desirable to bond only a portion of the spacers to both the topsheet and the substrate, for example every fourth spacer in a row or column of spacers. **FIG. 5** depicts another exemplary case where resistive touch sensor **10***c* includes a plurality of dot spacers **24***c* and a plurality of line spacers **25**, the dot spacers **24***c* being bonded only to resistive layer **18***c* of substrate **14***c,* and the line spacers **25** being bonded to both resistive layer **18***c* of substrate **14***c* and resistive layer **16***c* of topsheet **12***c.* The present invention contemplates any suitable construction where the size, shape, placement, and bonding characteristics (e.g., single versus double) of the spacers are varied or mixed.

[0029] Optional coatings and layers can also be provided such as hard coat layers, antireflective layers, light diffusing layers, anti-microbial layers, and so forth, as will be appreciated by those of skill in the art. For example, a hard coat provided on the top surface of the topsheet can help protect the sensor from scratches. A hard coat is typically a cured acrylic resin, coated onto the surface of a substrate by applying a liquid acrylic material, then evaporating away the solvents in the liquid, then curing the acrylic with UV radiation. The acrylic may also contain silica particles that give a roughened finish to the cured hard coat, yielding anti-glare or diffusing optical properties.

[0030] Spacers included in transparent touch screens preferably have characteristics that cause the spacers not to undesirably interfere with light to be transmitted through the sensor, for example from a display. For example, the spacers can be made having a dimension small enough so as not to be noticed by a user. The spacers can be shaped to inhibit the focusing of light passing through the touch screen although practically this may be difficult. According to the present invention, adverse effects due to light focusing through the spacers may be alleviated by bonding the spacers to both the top and bottom layers. Focusing of light by spacer dots can make them more visible to the user. In addition, by bonding the spacers to both the substrate and to the topsheet according to the present invention, an air interface is eliminated that may allow transmission of visible light through the spacers, making the spacers appear as bright spots, segments, or lines to the user. To minimize this in situations where the effect is undesirable, the spacers can be made as small as possible, light diffusing particles may be added to the spacers to scatter light, the spacers can be tinted with a color or made of a material that does not transmit light, for example to minimize visibility, and so forth.

[0031] Resistive touch sensors can be made according to the present invention by bonding a plurality of spacers disposed in the touch-sensitive area of the touch sensor to both the topsheet resistive layer and the substrate resistive layer. For example, a plurality of spacers can first be disposed on and adhered to either the topsheet resistive layer or the substrate resistive layer. This can be done by any suitable patterning method such as screen printing, photolithography, micro-molding, ink jet printing, or the like. If the disposed spacers comprise a bonding material, it may be possible to then adhere the other of the topsheet or substrate directly to the spacers. For example, the spacers may include a partially cured material that can be contacted with the other of the topsheet or substrate and then more fully cured to bond the spacers to the other layer. As another example, the spacers may include a thermoplastic material that can be heated during contact with both the substrate and the topsheet so that upon cooling the spacers are adhered to both layers. In other cases, an adhesive or other bonding material can be disposed on each spacer after the spacers have been disposed so that the other layer can be bonded to the spacers via the added adhesive or bonding material.

[0032] FIGS. **6**A-C show steps that may be performed according to the present invention. **FIG. 6A** shows a substrate **100** on which is disposed a resistive coating **102**.