touch sensitive surface due to a touch input. Each of the force activated devices includes first and second electrodes spaced apart a predetermined distance from each when in a rest state, with a measurable capacitance existing between the first and second electrodes. Structured elements having a predetermined maximum dimension are positioned between the first and second electrodes to control the predetermined distance. The applied force to the touch sensitive surface causes a change in the distance between the first and second electrodes and a related change in the capacitance. A change in capacitance of each device can be measured to determine information related to the location of the touch input to the touch sensitive surface.

[0012] In a further aspect of the invention, a monitor having force-based touch capabilities includes a screen and a force activated device positioned adjacent the screen for detecting an applied force to the screen. The force activated device includes first and second electrodes spaced apart a predetermined distance from each other when in a rest position, with a measurable capacitance existing between the first and second electrodes. Structured elements having a predetermined maximum dimension are positioned between the first and second electrodes to control the predetermined distance. The applied force to the screen causes a change in the distance between the first and second electrodes and a related change in the capacitance that can be measured to determine information related to the applied force.

[0013] In yet another aspect of the invention, a method is provided for manufacturing a capacitive device capable of detecting differences in an applied force over a continuous range of applied force including zero force. The device includes opposing first and second electrodes spaced apart a predetermined distance when in a rest state, the sensor having a capacitance controlled by the relative spacing between the first and second electrodes. The method includes spacing apart the first and second electrodes the predetermined distance with structured elements having a predetermined maximum dimension. The applied force to the capacitive device causes a change in the distance between the first and second electrodes and a related change in the capacitance that can be measured to determine information related to the applied force.

[0014] A yet further aspect of the invention relates to a connecting material for use in a capacitive device capable of detecting differences in an applied force over a continuous range of applied force including zero force. The device may include opposing first and second electrodes mounted to a substrate and spaced apart a predetermined distance when in a rest state. The capacitance of the sensor may be controlled by the relative spacing between the first and second electrodes. The connecting material includes a curable material and structured elements mixed within the curable material. The structured elements have a predetermined dimension and the connecting material is used to mount the first electrode to the substrate to control the predetermined distance with the structured elements.

[0015] Other features and advantages of various embodiments of the present invention will become apparent from the following description and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] **FIG. 1** is a schematic top perspective view of one example of a force-based touch sensor assembly according to principles of the invention.

[0017] **FIG. 2** is a schematic side view of one example of a capacitive force sensitive device according to the principles of present invention.

[0018] **FIG. 3** is a schematic side view of another example of a capacitive force sensitive device according to the principles of present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] In one of its aspects, the invention provides a novel capacitive force sensitive device. As described in more detail below, the device of the present invention may provide a more reliable, sensitive and accurate characterization of input forces to the devices. These improved properties of the device may be particularly advantageous when the device is used in small applications such as mobile and hand-held devices, as well as when used in larger applications such as computer monitors and other applications that require a high degree of touch and/or force sensitivity. It is anticipated that the present invention may be more broadly applicable to any application in which a force input must be characterized by, for example, the amplitude, the duration, or acceleration or speed of the force input.

[0020] One aspect of the present invention relates to a capacitive device configured to detect differences in an applied force over a continuous range of applied force including zero force. The device includes first and second electrodes that are spaced apart a predetermined distance from each other when in a rest position, and a measurable capacitance exists between the first and second electrodes. Structured elements having a predetermined maximum dimension are positioned in the device to control the predetermined distance between the first and second electrodes. The applied force to the device causes a change in the distance between the first and second electrodes and a related change in the capacitance that can be measured to determine information related to the applied force.

[0021] A force-based sensor assembly **100** that includes principles of the present invention is illustrated in **FIG. 1**. Sensor assembly **100** includes an input structure **102** with first and second input surfaces **101**, **103**, and first, second, third and fourth transducer assemblies **110**, **112**, **114**, **116** positioned adjacent second surface **103** at different locations around input structure **102**. Transducer assemblies **110**, **112**, **114**, **116** are electrically connected to a control module (not shown), and are configured and arranged to detect the location of a touch input to first surface **101**. For example, an object **104** may apply a force along an axis **106** so as to produce a force in a normal direction **108** to input surface **101** that is detected by transducer assemblies **110**, **112**, **114**, **116**. The amount of force detected by each of the transducer assemblies **110**, **112**, **114**, **116** can be used by the control module (not shown) to translate the applied force detected by each transducer assembly into a positional determination of the applied force by object **104**.

[0022] The transducer assemblies **110**, **112**, **114**, **116** utilize displacement caused by the applied force and capacitive