DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0021] The present invention is directed generally to touch displays that include an electroluminescent (EL) display and two or more force sensors that are used to determine a location of a force applied to a touch surface based on the forces passed through the touch surface to the sensors. It is generally desirable to have relatively thin and compact displays for a number of applications. Moreover, it is also desirable to have touch input capability in such displays. Many touch displays that are incorporated onto thin displays incorporate a conventional capacitive or resistive touch sensor onto an LCD. There are a number of problems associated with such displays. First, it is typically required that the touch sensor be physically separated from the display. This is because the liquid crystal displays are not well adapted to be touched. For example, the polarizer necessary for display function may be damaged. Moreover, when touching a LCD there is a noticeable effect, often referred to as bruising, that occurs as the liquid crystal material is compressed and displaced. This effect is not only distracting, but highlights the sensitivity of such displays to repeated touches. Rigidizing LCDs to make them less susceptible to bruising involves using much thicker glass as the front LCD substrate or using a rigid overlay spaced apart from the front of the LCD. Either case can result in a thicker, heavier display, and may additionally result in losses to resolution, contrast, and transmission.

[0022] Another problem with a conventional LCD/touch sensor arrangement is the durability of such displays. It is difficult to make LCDs that have high temperature durability and performance in a wide variety of end use applications. Additionally, it is difficult to construct touch sensors that are also adaptable to such environments. For example, a conventional resistive touch sensor typically has a glass surface coated with a transparent conductive material such as ITO and a polymer surface also coated with a transparent conductive material spaced apart from the glass surface. Such sensors are not well adapted for use in high temperature environments.

[0023] In accordance with one embodiment of the present invention, the above drawbacks of conventional touch displays are overcome. As illustrated in **FIG. 1**, an EL display **101** is used as the display element. The EL display does not have the above-described drawbacks associated with LCDs. In particular, EL displays have good temperature durability and by virtue of their construction, are not susceptible to damage by repeated touches.

[0024] The EL display **101** is supported by two or more force sensors **103**. The force sensors **103** are mounted on a support base **105**. When a point on the top surface **107** is touched, a force will be imparted through the EL display to the force sensors **103**. By measuring the relative magnitudes of the forces at the location of the sensors, a position of the touch can be determined. One advantage of such an arrangement is that the location of the touch can be determined independent of the instrument used to touch the surface **107**. For example, a stylus may be used, a finger may be used, or a finger wearing a glove. In each instance, the force sensors **103** will register a touch on the surface **107** of the EL display **101** in a similar manner.

[0025] The electroluminescent display **101** can be any of a variety of known electroluminescent displays. For example, the display may be an organic electroluminescent display (OLED), an inorganic electroluminescent display, or a display based on the combination of the two. The EL display **101** may be a segmented display, a pixilated display, a high information content or low information content display, and the like. The display may further be a multi-colored display, full-colored display, or a monochromatic display as desired in the particular application.

[0026] The force sensors, as well as the housing and other elements (not shown) are preferably the force sensors described in International Publications WO 2002/084580, WO 2002/084579, WO 2002/084578, and WO 2002/084244, all of which are incorporated herein by reference.

[0027] The surface **107** of the EL display **101** may further have additional functionality. For example, structures may be incorporated into the surface **107** that serve to extract light more efficiently from the EL display **101**. Such structures are described in co-pending International Publications WO 2002/37568 and WO 2002/37580, the contents of which are incorporated herein by reference. These structures may also serve to impart a textured surface to the surface **107** of the EL display **101** to provide a more tactilely accurate surface for writing or otherwise using a writing implement on the surface of the display.

[0028] The surface **107** of the EL display **101** may further have contrast enhancement functionality integrated thereon. For example, a circular polarizer may be laminated or otherwise attached to the emitting surface side of the of the EL display. The circular polarizer will function to provide contrast enhancement when the display is used in conditions where a significant amount of ambient light is present. Such contrast enhancement is particularly desirable due to the high reflectivity of the typical electrode used in EL display **101**. As an alternative, color filters may be used for contrast enhancement. Color filters are particularly well suited for monochrome or segmented color displays. In such a system, a filter designed to absorb all wavelengths of light other than that emitted by the particular display (or segment) is disposed over the display. The above described contrast enhancement color filters are known to those of skill in the art.

[0029] The surface **107** of the EL display **101** may also be treated to have anti-reflective properties. For example, various coatings of different materials having different refractive indices may be used to decrease the amount of reflection. Alternatively, or in addition to the anti-reflection, the surface may be provided with an anti-glare surface. The anti-glare surface may be achieved by etching the surface **107** of the EL display, or by laminating or otherwise adhering a textured surface onto the surface **107**. Alternatively, an anti-glare coat may be sprayed directly onto the surface of the EL display **101**.

[0030] The surface **107** of the EL display **101** may also be treated with other functional layers. For example, a low surface energy material may be applied to the surface in order to increase cleanability of the display. A hardcoat may be applied to the surface **107** to improve durability of the display in response to multiple touches. An anti-microbial treatment may also be applied to the surface of the EL display as described in co-pending International Publication WO00/20917, the contents of which are incorporated herein