TOUCH PANEL AND ELECTRONIC DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of Invention

[0002] The present invention relates to a touch panel capable of input by a finger, a pen, or the like.

[0003] 2. Description of Related Art

[0004] Currently, touch panels have been developed as coordinate detection devices, mounted on electronic devices, such as small portable information devices, and capable of input by a finger, a pen, or the like. Known touch panels for position detection as in the coordinate detection devices are of a resistive contact type and an electrostatic capacitive coupling type which can achieve a simple structure and a thin profile of the touch panels. The resistive contact type includes an analog resistive contact type and a digital resistive contact type. The former is capable of analog input, such as character input, and the latter is capable of on-off actions of a switch at the position of the touch panel touched by a finger, a pen, or the like.

[0005] All types of touch panels, that is, the analog resistive contact type, the digital resistive contact type, and the electrostatic capacitive coupling type for position detection, can have the same basic structure in which a pair of substrates oppose each other with a predetermined spacing therebetween and have a pair of transparent electrodes in a predetermined configuration on the inner surfaces of the substrates.

[0006] Referring now to **FIG. 11**, the structure of the analog resistive contact-type touch panel will be briefly described by way of example of a known touch panel. **FIG. 11** is an exploded perspective view illustrating a known analog resistive contact-type touch panel **100**.

[0007] As shown in **FIG. 11**, the touch panel **100** has a lower substrate **101** and an upper substrate **102** opposing each other with a predetermined spacing therebetween and an air space (not shown) is interposed therebetween. A lower transparent electrode **105** and an upper transparent electrode **106** made of indium tin oxide, etc., are formed on substantially the entire inner surfaces of the lower substrate **101** and the upper substrate **102**, respectively. The resistive contact-type touch panel **100** for position detection has a structure in which the upper substrate **102** is formed of a flexible substrate, such as a plastic film or the like, and is deformed at a position thereof which is pressed by a finger, a pen, or the like so that the lower transparent electrode **105** and the upper transparent electrode **106** are brought into contact with each other.

[0008] When a known touch panel of the analog resistive contact type, the digital resistive contact type, or the electrostatic capacitive coupling type is mounted on the view side of a display device such as a liquid crystal panel, outside light entering from the operator side is incident on the upper substrate, passes through the upper transparent electrode, the air space, the lower transparent electrode, and the lower substrate in that order, and then is incident on the display device. Light emitted from the display device passes through in the reverse route and is emitted from the operator side.

[0009] While the refractive index of the air space is 1, the refractive index of either of the transparent electrodes is large, that is, about 1.97. The difference in the refractive indexes of the air space and the transparent electrode causes light incident on the transparent electrode from the air space, or vice versa, to be reflected at the surface of the transparent electrode, i.e., at the boundary between the air space and the transparent electrode. This leads to lower light transmittance of the touch panel, thereby possibly resulting in lower visibility of the display device.

[0010] To solve this problem, a proposal has been made in which a liquid space having a refractive index close to that of the transparent electrode is interposed between the pair of substrates instead of the air space. Though the liquid space interposed between the pair of substrates prevents the light reflection at the surface of the transparent electrode, air bubbles may be formed in the liquid space, thereby possibly causing a problem of lower visibility of the display device provided with this type of touch panel.

SUMMARY OF THE INVENTION

[0011] The present invention has been made in view of the above problems. Accordingly, it is an object of the present invention to provide a resistive contact-type touch panel or an electrostatic capacitive coupling-type touch panel having high light transmittance by reducing the light reflection at the boundaries between an air space and transparent electrodes.

[0012] A touch panel according to the present invention can include a pair of substrates opposing each other with a predetermined spacing therebetween, a pair of transparent electrodes formed in a respectively predetermined pattern on the inner surfaces of the pair of substrates, and a plurality of projections formed on the surface of at least one of the pair of transparent electrodes with a substantially periodical pitch shorter than any wavelength of visible light.

[0013] An air space is preferably formed between the pair of electrodes. When the projections and depressions are formed in a substantially periodical manner on the surface of the transparent electrode, light incident on the transparent electrode from the air space is reflected and diffracted at the lower transparent electrode. However, the projections and depressions formed with a substantially periodical pitch shorter than any wavelength of visible light reduce the light reflection and diffraction at the boundary between the air space and the transparent electrode. The projections and depressions thus increase light transmission on the transparent electrode. Accordingly, the light reflection and diffraction at the boundary between the air space and the transparent electrode can be reduced in the touch panel of the present invention.

[0014] Each of the projections is preferably formed to become smaller from the bottom to the top thereof. Defining the shape of the projection to be tapered in this manner serves to ease a sudden change in the effective refractive index in the region between the air space and the outer surface of the substrate, thereby further reducing the reflection and diffraction at the boundary between the air space and the transparent electrode.

[0015] The projection can preferably formed to become smaller in a continuous or stepwise manner from the bottom to the top thereof, particularly as a truncated pyramid or a truncated cone or as a pyramid or a cone.