Touch Sensors based on PolyTC Transparent Conductive Films

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Abstract

Touch sensors have replaced keys and controls in many devices and gadgets. In combination with displays very intuitive control possibilities have been created. The most common principles to sense touch are resistive systems and projected-capacitive systems (mutual-capacitance and self-capacitance). These approaches are all based on electrical conductivity of transparent layers. In this paper a new method to attain very thin and flexible touch sensors manufactured by a high resolution roll-to-roll production process on plastic substrate is presented. The conductivity is based on a metallic grid, occupying only a small fraction of the surface and due to structure sizes down to 10µm appearing transparent. Using two layers of such a transparent conductive film (PolyTC) we can process touch sensors in a resistive or in the projected-capacitive setups, being capable of multi-touch sensing. These touch sensors are compatible with conventional image processing controllers. They are flexible and have a total thickness of less than 200µm.

Introduction

The most common materials used today to provide conductivity while being transparent are transparent conducting oxides (TCO) such as indium tin oxide (ITO). Processing ITO typically involves sputter deposition, photolithography and due to high process temperatures typically glass is used as substrate. Furthermore ITO layers of higher conductivity are inelastic and brittle. These properties induce non-flexibility, high thickness and high production costs to ITO based touch sensors.

In this paper very thin and flexible touch sensors manufactured by roll-to-roll production process are introduced. They are based on a high resolution process originally developed to print electrodes of integrated polymer electronics circuits [1] on flexible plastic substrates, e.g. polyester film. Employing this process structure sizes down to 10µm can be created, which is far beyond what the human eye is able to resolve. Therefore even opaque metal structures appear transparent when occupying only a small fraction of the surface (e.g. < 10%), while providing electrical conductivity to the film with a sheet resistance below 20 Ohms per square [2]. This type of transparent conductive film is called PolyTC.

Touch Sensors

Using two layers of PolyTC transparent conductive films we can process touch sensors in a resistive setup as well as the projected-capacitive setups, mutual-capacitance and self-capacitance.

In the resistive setup a spacer layer consisting of tiny spacer dots is sandwiched in between two transparent conductive layers facing each other. The position is sensed by pressure, when the two conductive layers are brought into contact, hence forming a voltage divider. From measuring its resistance the position is determined. Therefore this setup is referred to as resistive setup. The pressure can either be applied by stylus or fingertip.

In the mutual-capacitance setup two transparent conductive layers of perpendicular arranged stripes are separated by an insulating layer. The intersection points of the rows and columns thus form separate capacitors. When a voltage is applied to the rows and columns, the presence of a fingertip close to an intersection point causes a change in the local electric field which is sensed as change of capacitance. The signals are processed by an image processing controller that calculates the position of the actual touch point. With the mutual-capacitance setup two or more points of contact can be sensed at the same time, which is referred to as multi-touch.

While being similar to the mutual-capacitance setup the self-capacitance setup has the advantage of producing a stronger signal and the disadvantage of being unable to resolve the exact location of more than one finger.

The touch sensors based on PolyTC transparent conductive films are compatible with conventional image processing controllers used with ITO based touch sensors. As being processed on polyester films their thickness is less than 200µm and they are flexible. Depending on the pattern the sheet resistance of the metallic grid is below 20 Ohms per square. ITO based touch sensors are usually more than 500µm thick, being rigid and usually processed on glass. In patterned ITO layers for touch sensors only sheet resistances of down to 150 Ohms per square are achieved [3].

Conclusion

Touch sensors based on PolyTC transparent conductive films are produced with a roll-to-roll production process. They show high conductivity and high sensing speed, a thickness of less than 200µm, are flexible and can be controlled by conventional image processing controllers. In terms of conductivity, thickness and flexibility they show advantages over ITO based touch sensors.

References

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Author Biography

Dietmar Zipperer studied physics at the University of York, UK and the University of Erlangen-Nuremberg, Germany, where he received a PhD for his work on polymer rectifiers in 2004.

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