New flexible films for touch screen applications achieve longer lasting display

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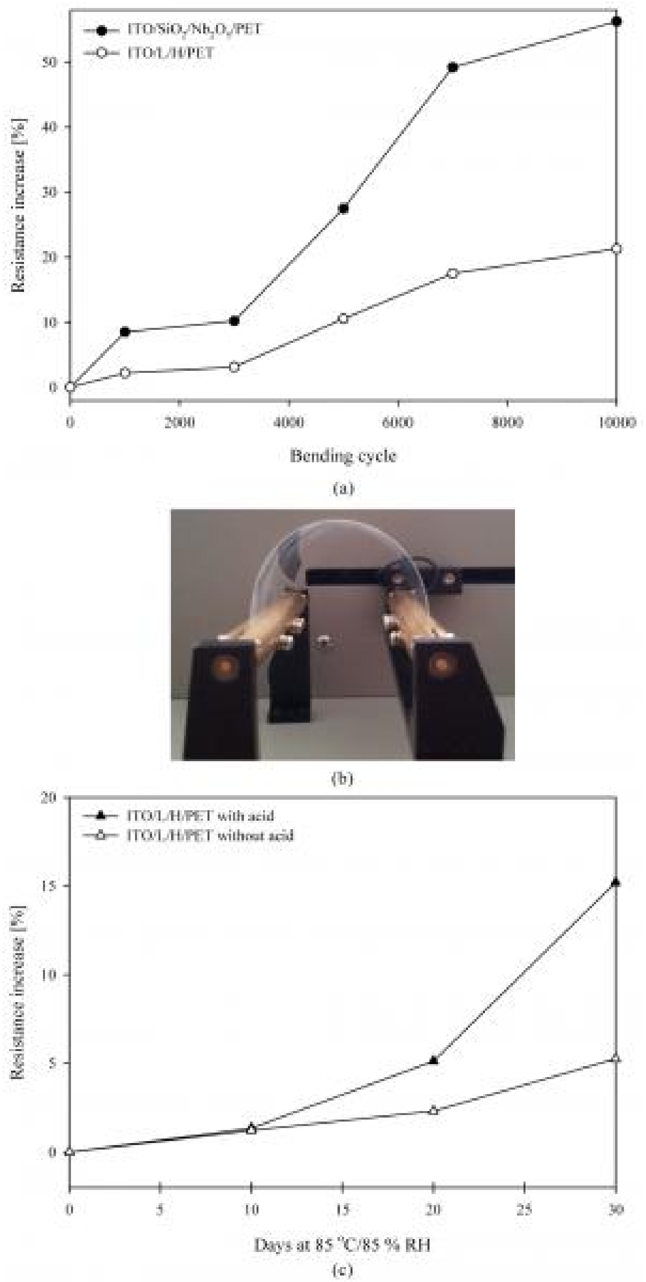

This is a plot of the percentage resistance increase of the ITO/SiO 2 /Nb 2 O 5 /PET and ITO/L/H/PET substrates as a function of the number of bending cycles [32-35] . (b) Photograph of the ITO/L/H/PET substrate during the bending test at minimum width of 40 mm. (c) Plot of the percentage resistance increase of the ITO/L/H/PET substrates prepared with and without acid as a function of the duration in a chamber maintained at 85 °C and 85% relative humidity Credit: Soo-Young Park

Today, touch screens are everywhere, from smart phones and tablets, to computer monitors, to interactive digital signage and displays. Many touch screens are made of layered thin (billionths of a meter thick) films of indium-tin oxide, an inorganic material that is electrically conductive, which allows electrical signals to travel from the "touch" to the edges of the display, where they are sensed by the device—as well as optically transparent.

But these and other inorganic materials have a downside, as anyone who has ever dropped their smart phone knows: they are brittle and shatter easily. The solution? Make the screens flexible and durable without sacrificing any of their electrical or optical properties. A paper in the latest issue of The Optical Society (OSA) journal *Optical Materials Express* describes a new type of thin film that achieves just that.

The paper by polymer scientists Soo-Young Park and A-Ra Cho of Kyungpook National University in Daegu, South Korea, describes a method to create a type of so-called "hybrid" film, composed of both inorganic and organic materials.

A process known as the sol-gel fabrication technique can create hybrid films— but it, too, is less than ideal, because it requires the use of acids that corrode the metals and metal oxides in the devices' electronic components. "Therefore," said Park, "acid-free methods of synthesizing organic–inorganic hybrid materials are needed for optical thin-film applications."

Park and Cho start with a co-polymer composed of two organic materials, methyl methacrylate and 3-(trimethoxysilyl) propyl methacrylate, which are combined with another chemical called trialkoxysilane. This co-polymer is then reacted with two inorganic chemicals, titanium isopropoxide and tetraethyl orthosilicate, to synthesize hybrid layers with high (1.82) and low (1.44) refractive indexes.

The refractive index is a measure of the extent to which light is bent as it passes through the material. Most transparent materials have indexes that fall between one and two. Inorganic thin-layer and hybrid films alike have layers with different refractive indexes to help tune the wavelengths of light that pass through the film (or touch screen).

Tests of the new hybrid films indicate that both the high and low refractive index layers are highly transparent—with transparencies of 96 percent and 100 percent, respectively, when compared to bare glass.

The new hybrid materials are produced entirely in solution, at low temperatures, and without the need for high-vacuum (i.e., very low-pressure) conditions, which significantly reduces production costs. In addition, the process allows for the creation of multilayered films in which the layers have thicknesses that would allow the films to be used for anti-reflective coatings, opening the door to potential new applications.

The hybrid films showed less depreciation in flexibility after 10,000 bending cycles than the inorganic layered films. Resistance of a material increases because of the formation of minute cracks as it flexes—just as it would when used in a flexible display screen. A film with higher resistance has lower electrical conductivity, meaning that more voltage must be applied to send a signal through it, which further degrades the material.

"The resistance increases less over time in the hybrid thin-layer film, so a display made from this type of film will last longer," Park said.

More information: Cho and S. Park, "Synthesis of titania- and silica-polymer hybrid materials and their application as refractive index-matched layers in touch screens," *Opt. Mater. Express* 5, 690-703 (2015). www.opticsinfobase.org/ome/abs … .cfm?uri=ome-5-4-690

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