

New low-cost, transparent electrodes

June 27 2013

Indium tin oxide (ITO) has become a standard material in light-emitting diodes, flat panel plasma displays, electronic ink and other applications because of its high performance, moisture resistance, and capacity for being finely etched. But indium is also rare and expensive, and it requires a costly deposition process to make opto-electronic devices and makes for a brittle electrode. Replacing indium as the default material in transparent electrodes is a high priority for the electronics industry.

Now, in a paper appearing in *APL Materials*, a new open-access journal produced by AIP Publishing, researchers report creating a sturdy, transparent, and indium-free electrode from silver (Ag) and [titanium dioxide](#) (TiO₂) that could replace indium-based electrodes in some applications.

"Silver and titanium are much more abundant than indium in the earth's crust, and so we anticipate that electronic devices based on silver and titanium dioxide would be a more sustainable materials system and be manufactured at a low cost," said T.L. Alford, a professor of Materials Science and Engineering at Arizona State University who led the research.

The TiO₂/Ag/TiO₂ composite electrode multilayer film the researchers studied has been well characterized in the literature, but the team optimized both the thickness of the silver layer and the manufacturing process so that the multilayer film has a low sheet resistance and high optical transmittance, both properties necessary for high-performance.

The researchers created films with a sheet resistance as low as one sixth of that achieved by previous studies, while maintaining approximately 90 percent optical transmittance. With the choice of an underlying substrate made of polyethylene naphthalate (PEN)—a sturdy polymer used in a variety of applications from bottling carbonated beverages to manufacturing flexible electronics—the researchers added additional durability.

Because of a less expensive manufacturing process and the wide availability of titanium dioxide, silver and PEN, the new TiO₂/Ag/TiO₂ thin film could one day help make devices such as electronic displays and solar cells more affordable by replacing more expensive indium-based [electrodes](#).

More information: [dx.doi.org/10.1063/1.4808438](https://doi.org/10.1063/1.4808438)

Provided by American Institute of Physics

Citation: New low-cost, transparent electrodes (2013, June 27) retrieved 26 April 2024 from <https://phys.org/news/2013-06-low-cost-transparent-electrodes.html>

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