

## Improved Transparent Conducting Oxides Boost Performance of Thin-Film Solar Cells

New top layer reduces the “wobble” that degrades the conversion of light to electricity in solar cells by absorbing light within a specific wavelength.

Today’s thin-film solar cells could not function without transparent conducting oxides (TCOs). TCOs act as a window, both protecting the cell and allowing light to pass through to the cell’s active layers.

Until recently, TCOs were seen as a necessary, but static, layer of a thin-film photovoltaic (PV) cell. But a group of researchers at the National Renewable Energy Laboratory (NREL) has identified a pathway to producing improved TCO films that demonstrate higher infrared transparency. To do so, they have modified the TCOs in ways that did not seem possible a few years ago.

NREL researchers demonstrated that controlled variation in the real part of the dielectric permittivity (which relates to a material’s ability to transmit or “permit” an electric field) of typical TCO films can have a profound effect on the optical properties of the material.

When light hits the solar cell, free electrons tend to resonate (or “wobble”) within a TCO, which can degrade a PV device’s performance. While researchers cannot stop the wobbling, they were able to control it by applying films made to absorb light within a specific band of wavelengths and moving the resonance point farther into the infrared, where the solar cell is not designed to respond.

NREL scientists believe that improved TCO films with permittivity control may both enhance module performance and lower the cost of PV products—a dual improvement that could advance the commercial success of thin-film PV.

Within 10 years, half of all glass manufactured is expected to be used for PV applications, and glass comprises half of the cost of PV manufacturing. NREL has filed several patents related to TCO work and has long-term working relationships with several major glass companies to commercialize the technology.

**Reference:** Gessert, Timothy A.; Burst, James; Li, Xiaonan; Scott, Marty; Coutts, Timothy. “Advantages of TCO Thin Films with Controlled Permittivity for Thin Film Photovoltaic Solar Cells.” *Thin-Solid Films*; accepted for publication.



### Key Research Results

#### Achievement

NREL has improved the performance of transparent conducting oxide (TCO) films on thin-film photovoltaic (PV) cells.

#### Result

Improved TCOs can enhance PV module performance and may lower the cost of PV manufacturing.

#### Potential Impact

These coatings improve the commercial prospects of thin-film PV.