# NREL Highlights

SCIENCE

# NREL Improves Hole Transport in Sensitized CdS–NiO Nanoparticle Photocathodes

Significantly improved charge-collection efficiencies result from a general chemical approach to synthesizing photocathodes.

It has been reported that a dye-sensitized nickel oxide (NiO) photocathode, when coupled to a dye-sensitized photoanode, could significantly increase overall solar conversion efficiency. However, the conversion efficiencies of these cells are still low. There has been much effort to improve the conversion efficiency by fabricating films with improved properties and developing more effective sensitizing dyes for *p*-type NiO. One of the factors limiting the use of NiO for solar cell application is the low hole conductivity in *p*-NiO.

A team of researchers from the National Renewable Energy Laboratory (NREL) developed a general chemical approach to synthesize NiO-cadmium sulfide (CdS) core-shell nanoparticle films as photocathodes for *p*-type semiconductor-sensitized solar cells. Compared to dye-sensitized NiO photocathodes, the CdS-sensitized NiO cathodes exhibited two orders of magnitude faster hole transport (attributable to the passivation of surface traps by the CdS) and almost 100% charge-collection efficiencies.

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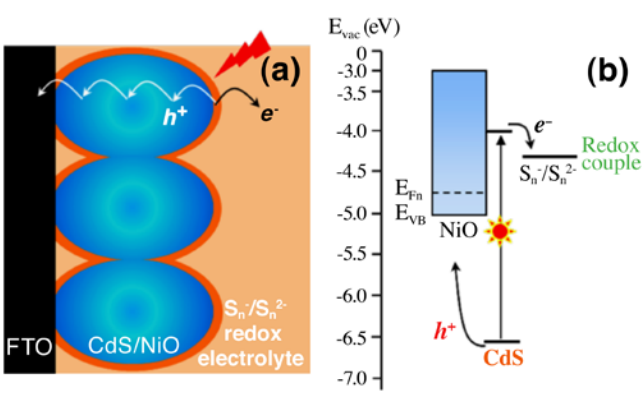
**Reference:** Kang, S.; Zhu, K.; Neale, N.R.; and Frank, A.J. "Hole transport in sensitized CdS–NiO nanoparticle photocathodes," *Chem. Commun*. 47, 10419 (2011).




*Schematics of CdS-NiO photocathode: Charge carrier dynamics of CdS-NiO electrode. Hole transport in the conformally coated CdS-NiO electrode is two orders of magnitude faster than dye-sensitized NiO electrode.* Illustration by Soon Hyung Kang for NREL

## Key Research Results

### Achievement

Researchers developed a chemical approach that resulted in CdS-sensitized photocathodes for photoelectrochemical solar cells.

### Key Result

Compared to dye-sensitized NiO photocathodes, the CdS-sensitized NiO cathodes exhibit two orders of magnitude faster hole transport and almost 100% charge-collection efficiencies.

### Potential Impact

NiO cathodes sensitized with CdS result in significantly higher charge-collection efficiencies than do dye-sensitized NiO photocathodes, demonstrating a successful approach to improving conversion efficiency by improving the properties of fabricated films.

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