

Metal Oxynitride Semiconductors for Solar Energy Conversion

Tech ID: 34389 / UC Case 2025-455-0

ABSTRACT

Researchers at the University of California, Davis have developed metal oxynitride compounds with reduced defect levels that enable improved solar energy conversion efficiency and higher stability than silicon under harsh conditions.

FULL DESCRIPTION

This technology involves metal oxynitride semiconductor compounds of titanium, tantalum, and niobium with perovskite crystal structures, synthesized at controlled ammonia concentrations to minimize reduced metal ion defects. These compounds exhibit band gaps between 1.8 eV and 2.1 eV and theoretical power conversion efficiencies from 12.5% to 19%. Optimized synthesis methods produce powders and thin films with brighter colors and improved photovoltaic performance for photoelectrochemical water splitting and photovoltaic solar energy applications.

APPLICATIONS

- ▶ Photoelectrochemical cells for water oxidation and green hydrogen generation.
- ▶ Photovoltaic solar cells with enhanced efficiency and durability.
- ▶ Photocatalysts for hydrogen evolution and water splitting.
- ▶ Semiconductor films for renewable energy devices.
- ▶ Advanced solar energy conversion materials for research and industrial use.

FEATURES/BENEFITS

- ▶ Reduces metal ion defect concentration through controlled ammonia synthesis.
- ▶ Provides greater stability than traditional silicon semiconductors.
- ▶ Improves photovoltage, photocurrent, and photocatalytic performance in solar energy conversion.
- ▶ Enables versatile synthesis using various metal oxides, salts, and metal halide fluxes.
- ▶ Enhances photocurrent density ~80% relative to reference films and photocatalytic activity by 200-400%
- ▶ Supports application to powder forms, thin films, and integrated photoelectrochemical cells.
- ▶ Addresses limitations caused by increased metal ion defects during traditional compound synthesis.
- ▶ Improves solar conversion efficiency compared to conventional oxynitride semiconductors.
- ▶ Resolves instability issues in semiconductor materials compared to silicon.

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OTHER INFORMATION

KEYWORDS

amendments, ammonia
concentration, band gap,
defect reduction, metal
oxynitride, perovskite
crystal structure,
photoelectrochemical
cells, photovoltaic
performance, solar
energy conversion,
production of hydrogen
under harsh conditions,
thin films

CATEGORIZED AS

- ▶ **Energy**
- ▶ **Solar**

PATENT STATUS

Patent Pending

RELATED MATERIALS

► Wang, L., M. Salmanion, R. Kandel, W. Hahn, G. Rao, Z. Najaf, K. van Benthem, R.D. Britt, and F.E. Osterloh, Ammonolysis Under NH3–Limiting Conditions as a Pathway to Improved LaTiO2N Water Splitting Photoanodes. ACS Applied Energy Materials, 2025. 8(21): p. 15799-15810 - 10/27/2025

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