ACHIEVEMENTS

Doing More with Less — Reducing Material Usage in Light-Driven Energy Conversion

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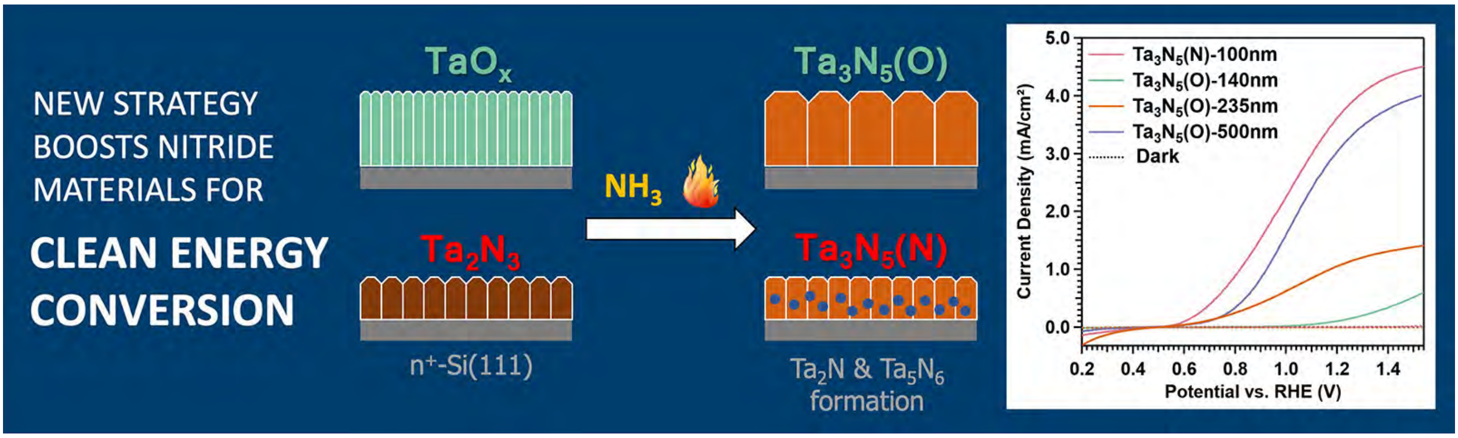
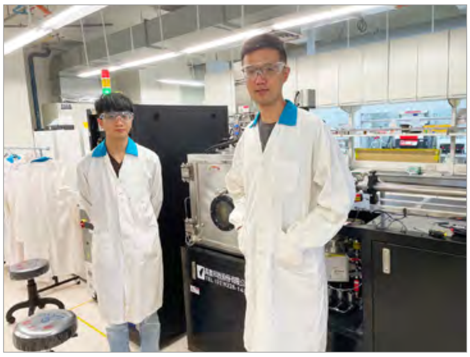


New strategy boosts Nitride materials for clean energy conversion.

Converting sunlight into renewable fuels is a central goal of clean energy research. One promising approach is photoelectrochemical (PEC) water splitting, that is, using semiconductor electrodes to harness sunlight to split water into its two elements: hydrogen, a clean fuel, and oxygen. Among candidate materials, tantalum nitride (Ta_3N_5) has long been attractive because it efficiently absorbs visible light. However, its performance has been limited by poor electrical conductivity, requiring thick films that consume large amounts of tantalum—a rare and costly element.



The lead author, Mr. Chia-Wei Chang, and Dr. Chang-Ming Jiang, standing in front of the reactive sputter deposition system used in this study.

In a new study published in *Small*, researchers in the Department of Chemistry at National Taiwan University present a breakthrough approach to tackling this challenge. By starting with a chemically engineered precursor called bixbyite-type Ta_2N_3, the team has developed ultrathin Ta_3N_5 photoanodes that operate efficiently while using far less tantalum. Unlike conventional methods, this strategy naturally produces small amounts of highly conductive subnitride phases at the interface with silicon support. Rather than being detrimental, these conductive impurities act like “highways” for charge carriers, helping electrons and holes move more efficiently and reducing the losses that usually limit Ta_3N_5.

Click or Scan the QR code to read the full article published in *Small*.

The resulting photoanodes demonstrate significantly improved charge separation and photocurrent output, even at reduced thickness. In effect, less tantalum is required yet performance is maintained or even enhanced. By applying advanced structural, optical, and electrochemical characterization, the researchers showed that the improved efficiency arises from innovative smart interface engineering between Ta_3N_5 and silicon.

"By rethinking how we design the interface, we can make Ta_3N_5 much more efficient without relying on thick, resource-intensive films and substrates," remarks Dr. Chang-Ming Jiang, an assistant professor in the Department of Chemistry and the corresponding author of the study. "This was only possible because NTU invested in a state-of-the-art reactive sputter deposition system, which allowed us to access the metastable Ta_2N_3 precursor. That infrastructure support was crucial for enabling this discovery."

Beyond water splitting, the insights from this work highlight a versatile design principle for other thin-film semiconductors, offering a blueprint for more efficient and sustainable solar energy technologies.

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