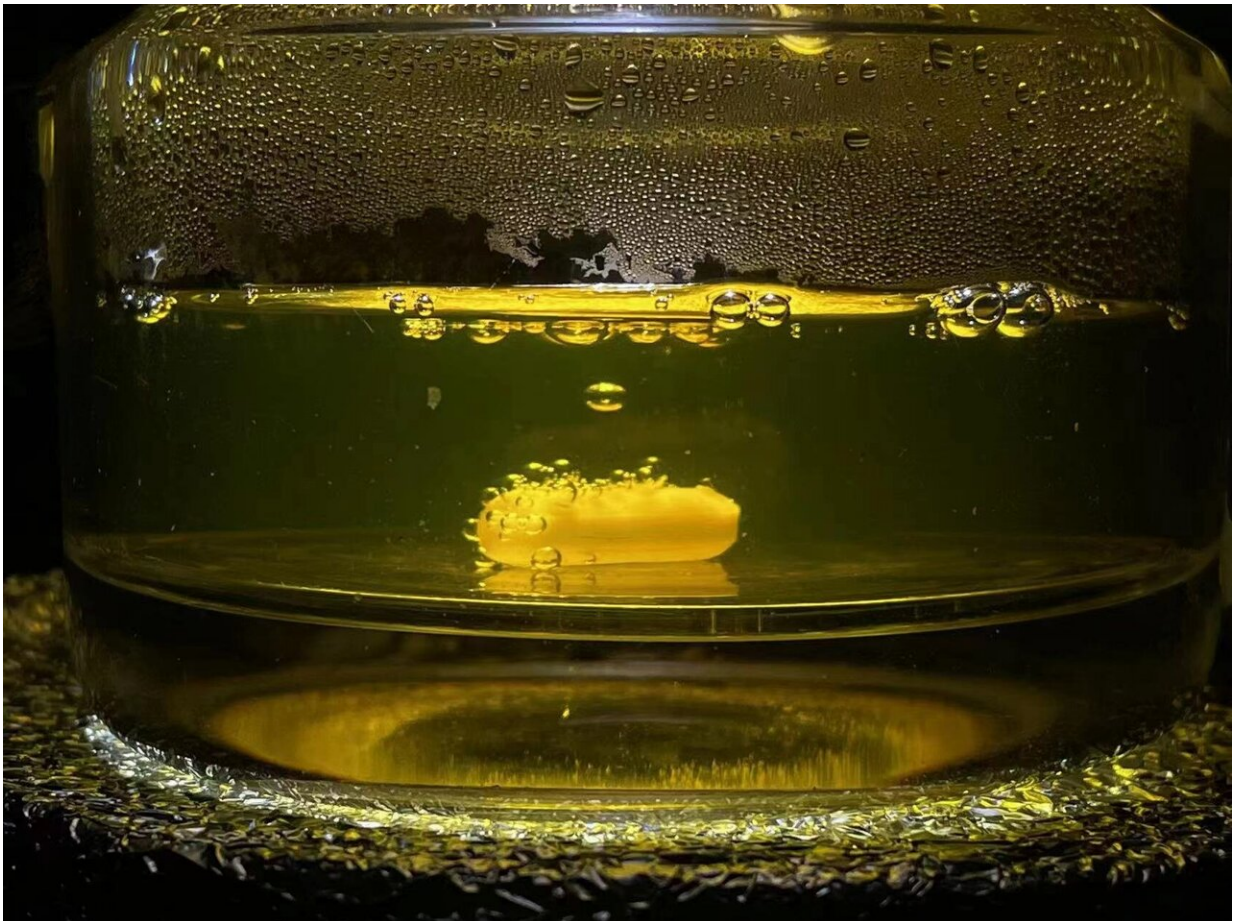


New nanomaterials could boost hydrogen production for clean energy

August 5 2024, by Wei Zhao



Optical image of nano-COF for photocatalytic H₂ production. Credit: Wei Zhao

Have you ever considered how nanotechnology could transform our

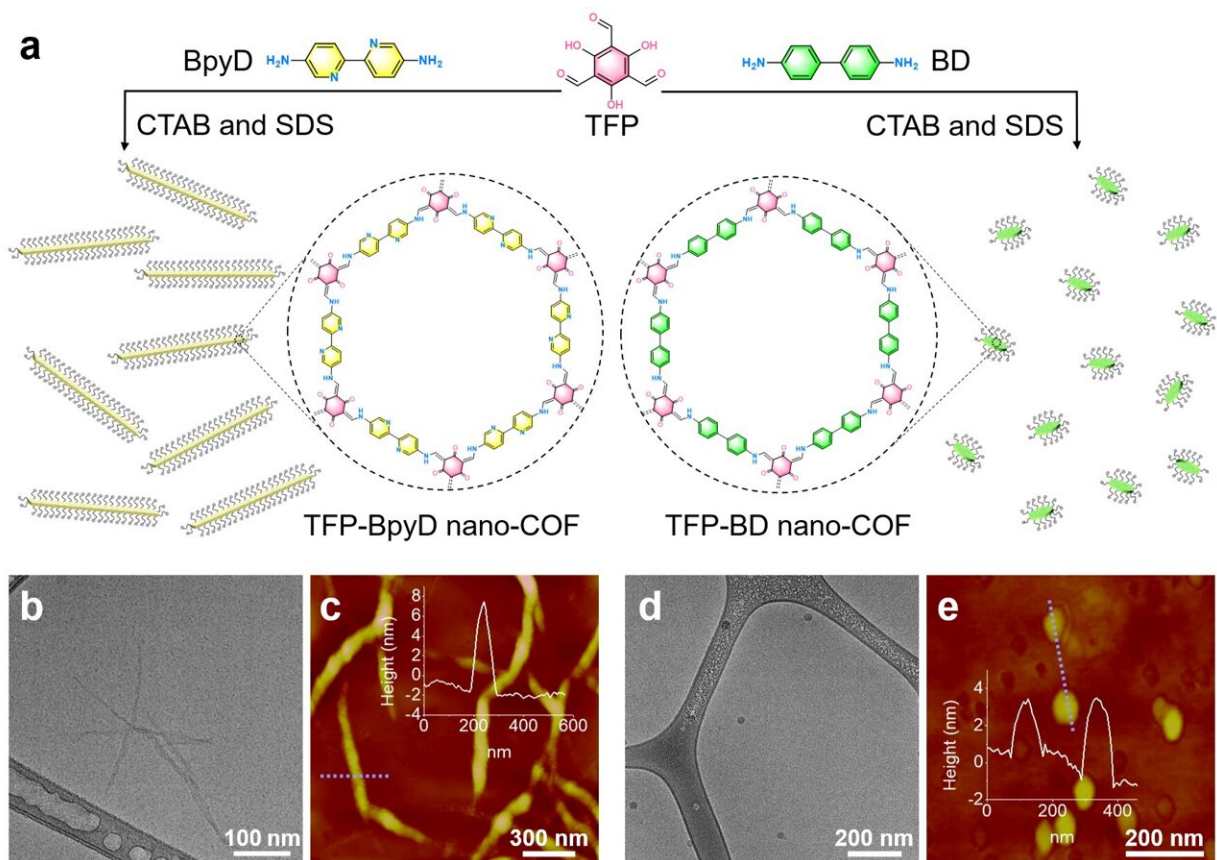
approach to clean energy? In recent research, we've been exploring nanoscale covalent organic frameworks (nano-COFs) that show exceptional potential for enhancing photocatalytic hydrogen production.

This study examines the synthesis and performance of these nano-COFs, paving the way for more efficient and sustainable [hydrogen](#) energy solutions. The study is [published](#) in the journal *Nature Communications*.

High active performance

Our study focuses on the synthesis and characterization of two specific nano-COFs, TFP-BpyD and TFP-BD, which exhibit remarkable activity in photocatalytic hydrogen production.

By reducing COF crystals to the nanoscale using surfactants, we've achieved significantly improved water dispersibility and light-harvesting properties. These advancements have led to impressive performance metrics, with one nano-COF demonstrating a hydrogen evolution rate of $392.0 \text{ mmol g}^{-1} \text{ h}^{-1}$. This rate is among the highest mass-normalized rates reported for any organic photocatalyst.



Synthesis of nano-COFs and their morphologies. Credit: Wei Zhao

Reverse concentration-dependent photocatalytic phenomenon

Apart from the nanosizing of COF crystals enhancing their photocatalytic properties, one of the fascinating outcomes of our research is the reverse concentration-dependent photocatalytic phenomenon observed, where higher photocatalytic activity is recorded at lower catalyst concentrations.

This result challenges the conventional wisdom that more catalyst usually

equates to higher activity, suggesting that there are optimal conditions for the most efficient operation of these nano-COFs.

Additionally, we've delved into the molecular excitonic nature of these nano-COFs, investigated through photoluminescence and transient absorption spectroscopy. This molecule-like excitonic behavior, a direct result of the nanoscale dimensions of the COFs, contributes significantly to their enhanced photocatalytic performance.

In summary, the nanosizing of COFs to create nano-COFs represents a significant advancement in the field of photocatalytic hydrogen production. These materials not only exhibit improved water dispersibility and light-harvesting properties but also demonstrate exceptional hydrogen evolution rates.

The discovery of the reverse concentration-dependent [photocatalytic](#) phenomenon adds an exciting dimension to the optimization of these materials.

Our research highlights the potential of nano-COFs to serve as highly efficient organic photocatalysts for solar fuel production. The future of sustainable energy solutions may well lie in the innovative use of nanoscale materials like these nano-COFs.

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Wei Zhao obtained his Bachelor's degree in 2015 from Hunan University. Then, he earned his MS degree in 2018 from Sichuan University under the guidance of Prof. Xikui Liu. He then moved to the University of Liverpool, where he successfully obtained his PhD in 2022 under the supervision of Prof. Andrew I. Cooper. Wei is currently furthering his research and expertise as a research fellow in Prof. Dan Zhao's group at the National University of Singapore. His research interests focus on the synthesis and applications of covalent organic frameworks, such as photocatalysis and sorption

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