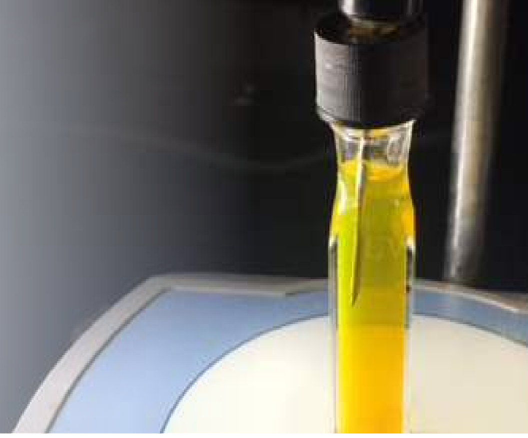
UNISENSE & SCIENTIFIC



Unisense microsensors in water splitting studies

The application note is based on the research and articles by:
Sick et al. (2018)
Wang et al. (2016)
The application note is written by:
Daugaard et al., Unisense

Hydrogen production at the surface of a semiconductor material

Photoelectrochemical water splitting is a promising route to sustainable hydrogen production, but progress is often limited by the performance of photoabsorber materials. To explore new options, Jonathan Kampmann and coworkers at the University of Munich investigated covalent organic frameworks (COFs) as a novel class of photoelectrodes.

Using a Unisense H2-NP low range microsensor, the team detected nanomolar hydrogen concentrations evolving directly in solution at the COF surface under light illumination (Figure 1).

The microsensor enabled continuous, sensitive detection of hydrogen formation, confirming the photoelectrochemical activity and stability of the oriented COF films. These findings demonstrate COFs as promising photoelectrodes for water splitting.

Read more in: Sick et al., J. Am. Chem. Soc. 2018, 140, 2085–2092.

Data and photo kindly provided by Jonathan Kampmann.

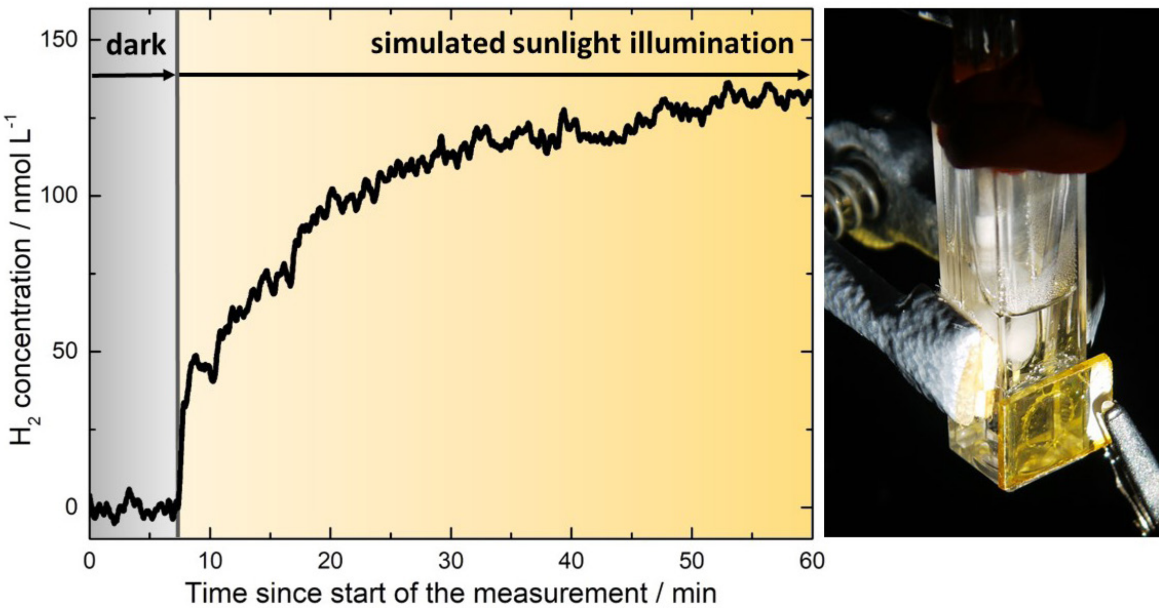
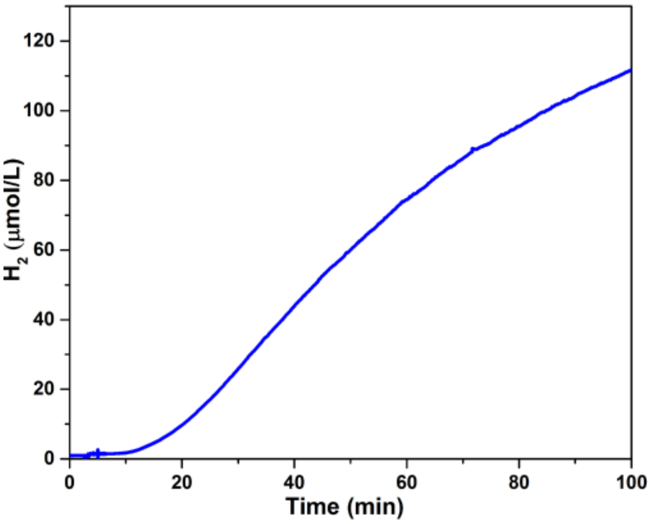


Figure 1: Microsensor measurement of the H2 produced during illumination (left). H2-NPLR microsensor in the cuvette containing the active semiconducting material and water (right).

Hydrogen production catalyzed by organic polymer dots

Organic semiconductors have emerged as promising photocatalysts for light-driven hydrogen generation, offering metal-free structures, tunable optical properties, and material abundance. Dr. Haining Tian and his group at Uppsala University investigated polymer dots (Pdots) as photocatalysts for visible-light-driven water splitting.

Using a Unisense H2-NP low range microsensor with a detection limit of 50 nM, hydrogen evolution was monitored directly in aqueous Pdot suspensions by inserting the microsensor through the cuvette lid. Continuous and sensitive measurements confirmed that the Pdots efficiently catalyzed hydrogen production under visible light, achieving activity several orders of magnitude higher than pristine polymer material.



Importantly, the Pdots also demonstrated tolerance to oxygen, a key advantage for practical application. These results highlight Pdots as a highly effective class of photocatalysts for hydrogen generation.

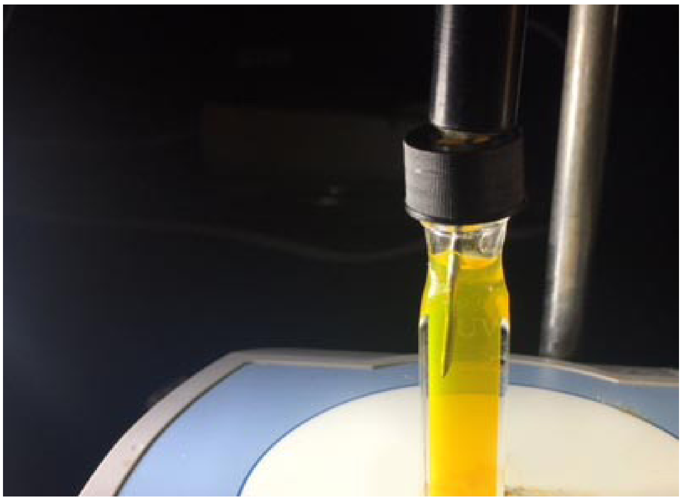


Figure 1: H_2 generation over time measured with the Unisense H_2-NPLR microsensor (left) and experimental setup showing the hydrogen microsensor pierced through the lid into the sample measuring the H_2 generation (above).

Data and photo kindly provided by Dr. Haining Tian.

For further reading please see the article: Wang et al. Organic Polymer Dots as Photocatalysts for Visible Light-Driven Hydrogen Generation. Angew. Chem. Int. Ed. 2016.

Suggested products

- H_2-NP
- Temp UniAmp
- Single or MultiChannel UniAmp
- uSense Solutions

Related publications

Mallón et al. Effect of Nitrogen and Phosphorus Doping of Reduced Graphene Oxide in the Hydrogen Evolution Catalytic Activity of Supported Ru Nanoparticles. ACS Applied Materials & Interfaces 2025, 17, 4, 6198-6210.

Hou et al. Enhanced electrocatalytic hydrogen evolution with bimetallic Ru/Pt nanoparticles supported on nitrogen-doped reduced graphene oxide. Inorg. Chem. Front., 2025, 12, 4569-4582.

Lalaoui et al. Gold nanoparticle-based supramolecular approach for dye-sensitized H2-evolving photocathodes. Dalton Trans., 2022, 51, 15716.

Liu et al. Hollow polymer dots: nature-mimicking architecture for efficient photocatalytic hydrogen evolution reaction. J. Mater. Chem. A, 2019, 7, 4797.

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