Illuminating Electron Microscopy of Photocatalysts

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Illuminating Electron Microscopy of Photocatalysts

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Background

Photocatalysts are of fundamental interest for sustainable energy research. By means of transmission electron microscopy (TEM) it is possible to obtain deep insight onto the structure, composition and operation of photocatalysts. The internal environment of a TEM can be modified in order to perform real time *in situ* experiments with light [1] or under other nonconventional TEM conditions.

This project is part of the CAtalysis for Sustainable Energy (CASE) initiative and involves characterization of catalysts using methods available at DTU Cen.

Applications

- Photocatalysts: Experiments under controlled gas and light exposure.
- Solar cells: Real time *in situ* electrical measurements of light harvesting materials and structures.
- Fundamental physics: Monitor light-matter interactions at the nanoscale.

Goals

- Study photo-induced effects on photocatalysts at the nanoscale.
- Investigate how photoreactive nanostructures behave under light exposure.
- Perform characterization of photocatalytic materials under simulated working environment (gas and light).

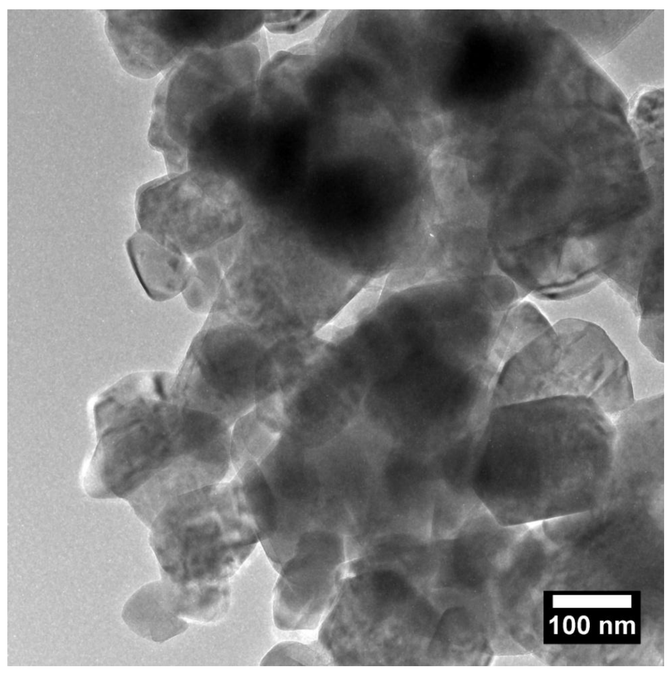
Focus

Experiments are performed to study light-induced phenomena:

- Structural changes
- Photoconductivity effects
- Variations in electromagnetic potentials

Projects

- Characterization of a GaZnNO-based photocatalyst for water splitting application (see figure).
- Characterization of GaAs nanowires for solar cells application.

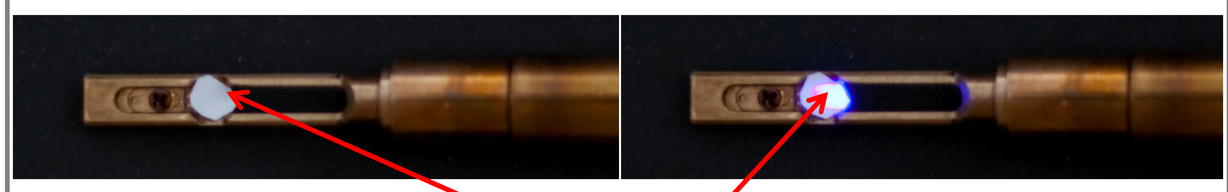


Experimental setup

A novel specimen holder capable of shining light onto samples inside the TEM has been developed.

The laser shines light into the holder from this position.

3D model of the specimen holder



Working principle

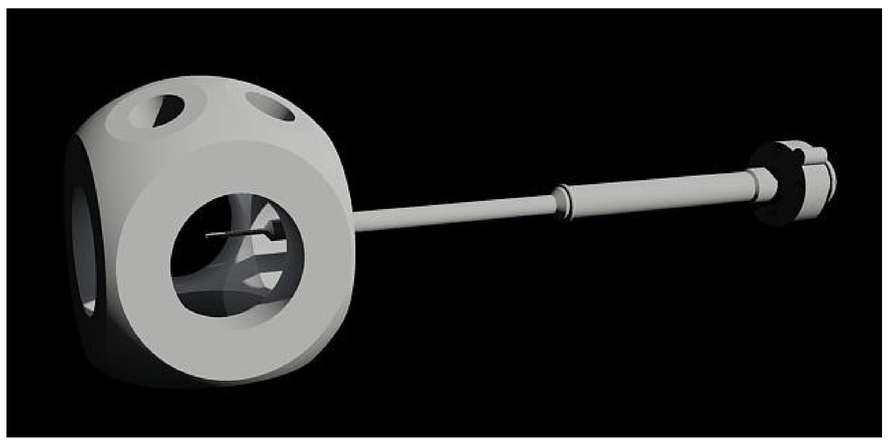
The holder is implemented with a laser diode and a lens system guiding and focusing light onto the sample surface with maximum power transmission (no fiber optics). The source can be changed and tuned, in principle spanning the whole visible and UV light spectrum.

It is possible to use the device inside DTU Cen's Environmental TEM to expose a specimen to a controlled gas atmosphere during illumination.

FEI Titan Environmental TEM

Prospects

- Feedthroughs of different kinds will be used to study a number of interactions with the specimen such as introducing electrodes, probes, magnetizing coils, heat and forces acting on the sample.
- A vacuum chamber for ex-situ experiments will be used to recreate the microscope environment and to allow performance tests and preliminary assessments before moving to the microscope.



Reference

[1] Shindo, D., K. Takahashi, et al. (2009). "Development of a multifunctional TEM specimen holder equipped with a piezodriving probe and a laser irradiation port." Journal of Electron Microscopy 58 no. 4: 245-249.

Acknowledgement:

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