

Technical University of Denmark



Illuminating Electron Microscopy of Photocatalysts

Cavalca, Filippo Carlo

Publication date:
2010

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Cavalca, F. (2010). Illuminating Electron Microscopy of Photocatalysts. Poster session presented at European Graduate School for Sustainable Energy : Spring meeting 2010, Munich, .

DTU Library

Technical Information Center of Denmark

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Illuminating Electron Microscopy of Photocatalysts

F. Cavalca^{1*}, T. W. Hansen¹, J. B. Wagner¹, B.E. Kardynal² and R. E. Dunin-Borkowski¹

¹ Center for Electron Nanoscopy, Technical University of Denmark, Fysikvej, Building 307, DK-2800 Lyngby, Denmark

² Department of Photonics Engineering, Technical University of Denmark, Ørsteds Plads 343, DK-2800 Lyngby, Denmark

*fica@cen.dtu.dk

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).

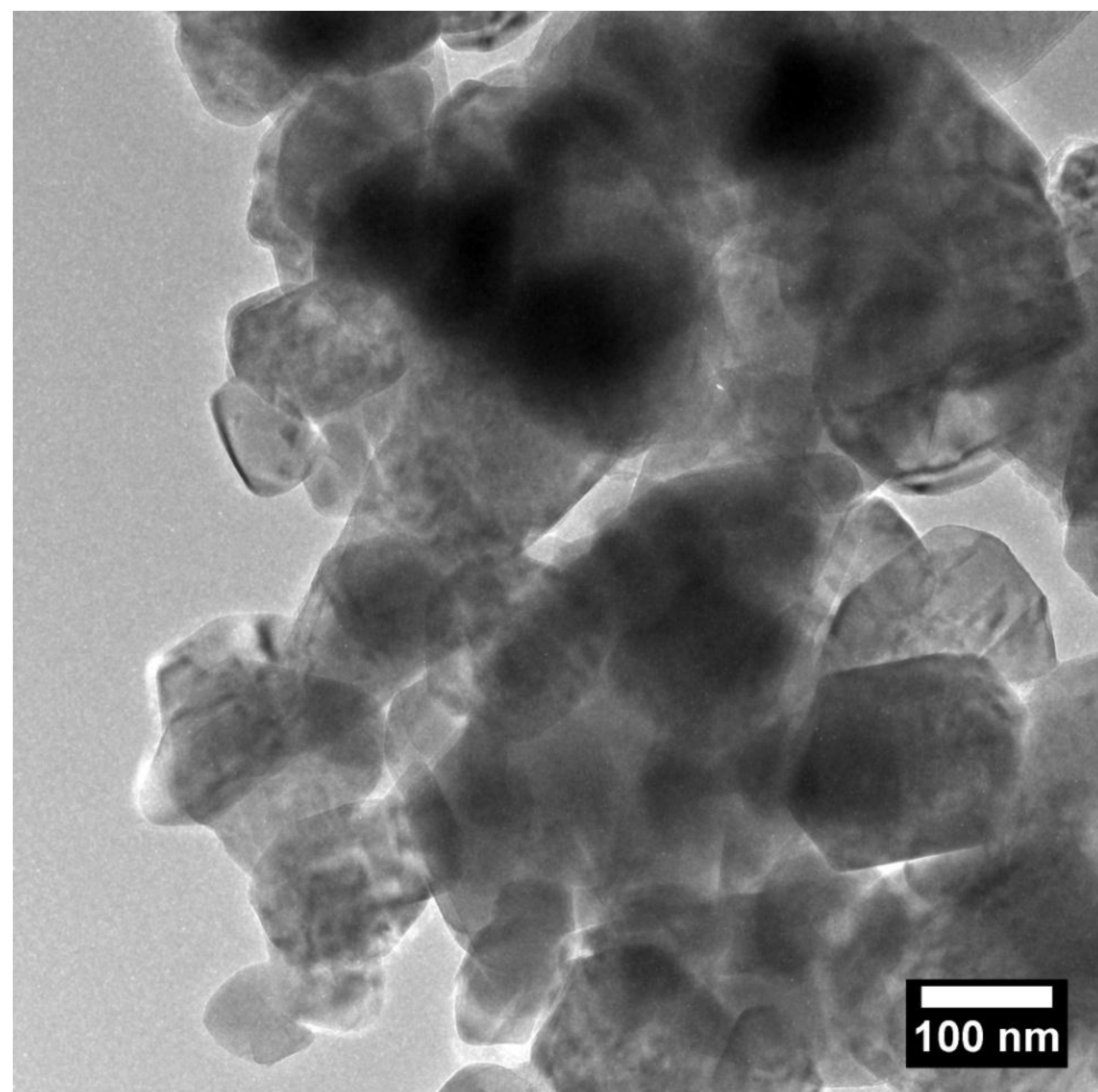
Focus

Experiments are performed to study light-induced phenomena:

- Structural changes
- Photoconductivity effects
- Variations in electromagnetic potentials

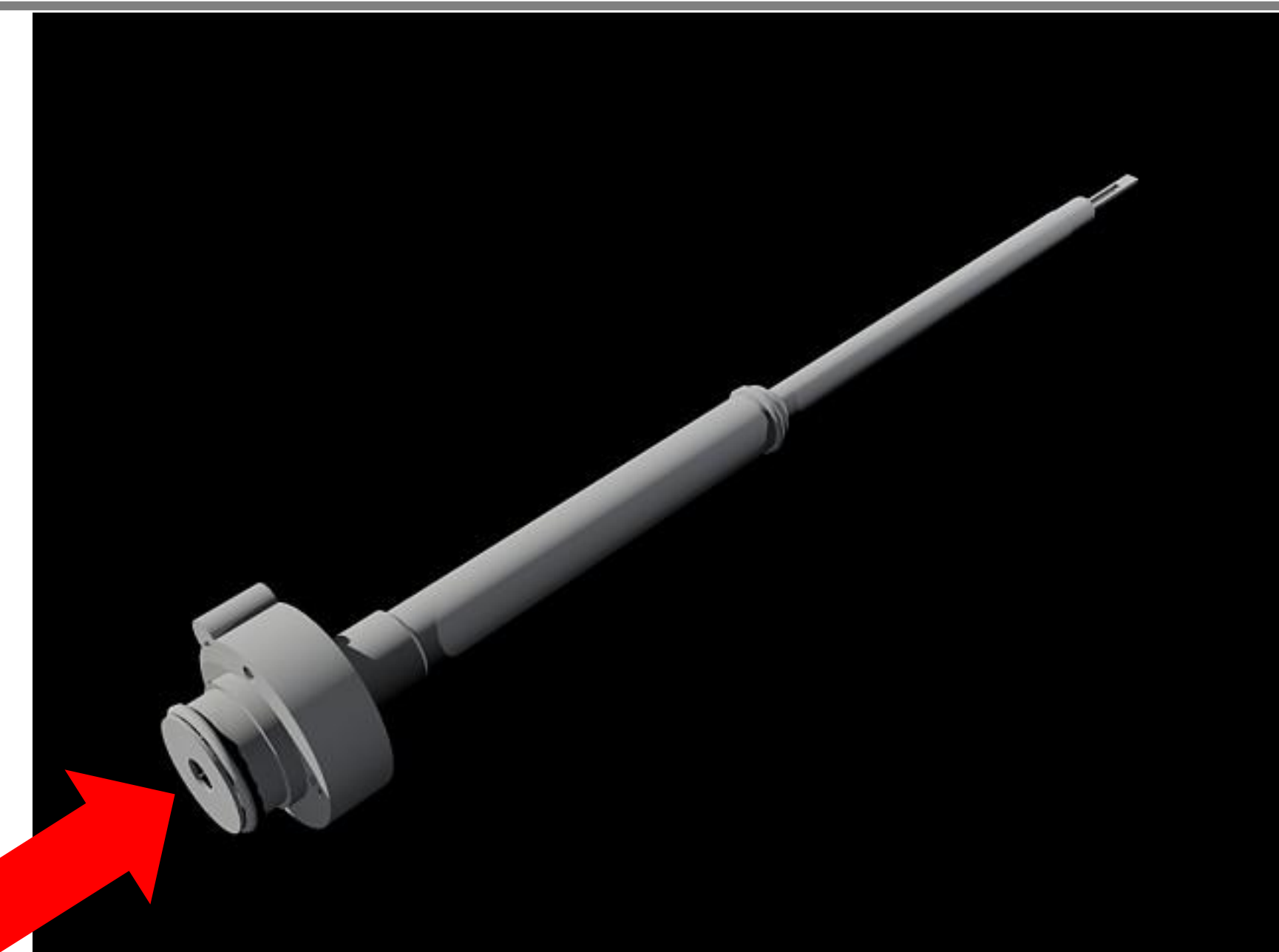
Projects

- 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



Light off

Sample

Light on

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.

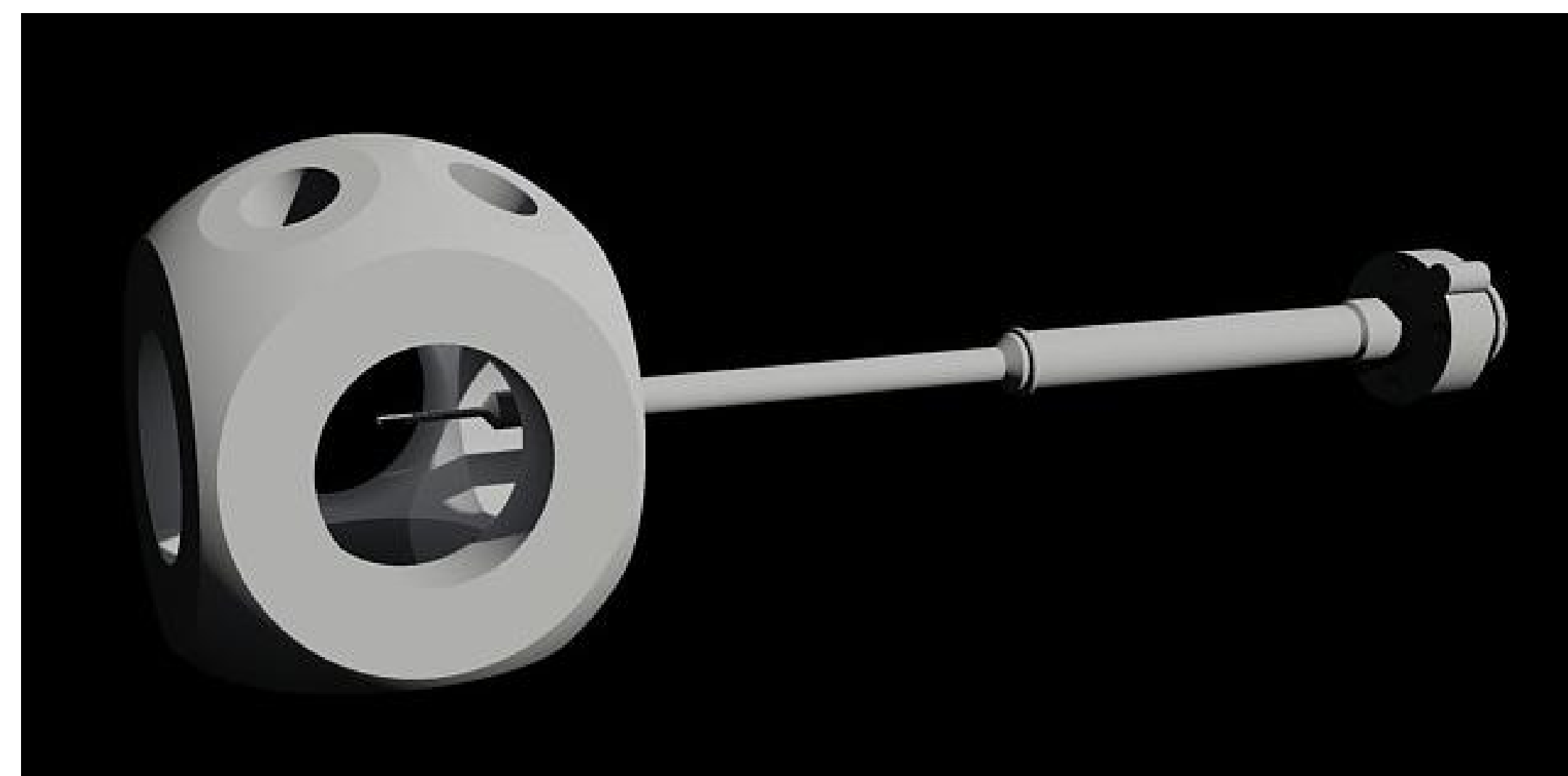
It is possible to use the device inside DTU Cen's Environmental TEM to expose a specimen to a controlled gas atmosphere during illumination.



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:

The Catalysis for Sustainable Energy initiative is funded by the Danish Ministry of Science, Technology and Innovation.