DTU Library

Transmission electron microscopy characterization of photocatalysts for water splitting

Cavalca, Filippo Carlo; Laursen, Anders Bo; Dahl, Søren; Kardynal, Beata; Dunin-Borkowski, Rafal E.; Wagner, Jakob Birkedal; Hansen, Thomas Willum

Publication date:
2012

Citation (APA):
Cavalca, F., Laursen, A. B., Dahl, S., Kardynal, B., Dunin-Borkowski, R. E., Wagner, J. B., & Hansen, T. W. (2012). Transmission electron microscopy characterization of photocatalysts for water splitting. Abstract from 2nd International Symposium on Advanced Electron Microscopy for Catalysis and Energy Storage Materials, Berlin, Germany.

Transmission electron microscopy characterization of photocatalysts for water splitting

*Filippo Cavalca[1, *], Anders B. Laursen[2], Søren Dahl[2], Beata E. Kardynal[3], Rafal E. Dunin-Borkowski[1,4], Jakob B. Wagner[1], Thomas W. Hansen[1]*
[1] Center for Electron Nanoscopy, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark
[2] Center for Individual Nanoparticle Functionality, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark
3 Department of Photonics Engineering, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark
4 Ernst Ruska–Centre for Microscopy and Spectroscopy with Electrons (ER-C) and Peter Grünberg Institute (PGI), Forschungszentrum Jülich, D-52425 Jülich, Germany
**: presenting author, email: Filippo.cavalca@cen.dtu.dk*

Abstract

As a result of diminishing fossil fuel reserves, there is an increasing need to switch energy dependence to renewable resources such as sunlight. Photocatalysts provide a viable route for converting solar energy into chemical bonds. In order to optimize the performance of such materials, it is necessary to understand the fundamentals of their reaction mechanisms, chemical behavior, structure and morphology before, during and after reaction using *in situ* investigations. Here, we focus on the *in situ* characterization of photocatalysts [1] in an environmental transmission electron microscope (ETEM) [2]. Such fundamental insight can be used for further material optimization with respect to performance and stability [3].

In this work, we combine conventional TEM analysis of photocatalysts with environmental TEM (ETEM) and photoactivation using light. A novel type of TEM specimen holder that enables *in situ* illumination is developed to study light-induced phenomena in photoactive materials at the nanoscale under working conditions.

Our experiments are aimed at exposing a specimen to light and detecting resulting microstructural and chemical changes using *in situ* TEM techniques. It is important to investigate photoactive materials under light illumination in order to remove the effects associated with handling of the specimen between *ex situ* reactions and TEM experiments. Two representative photoinduced phenomena are studied: the photodegredation of Cu_2O and the photodepositon of Pt onto a GaN:ZnO photocatalyst (Figure 1).

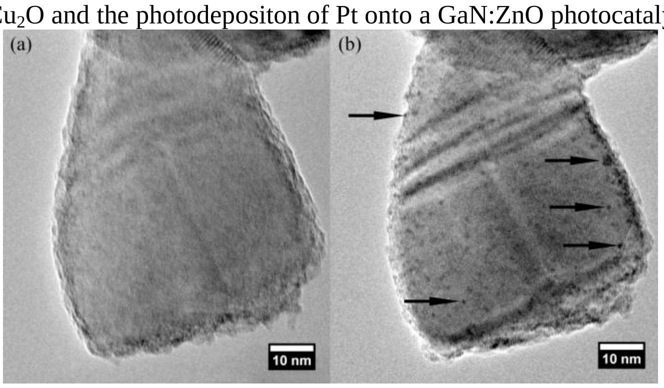

Figure 1: (a,b) Bright field TEM images of a GaN:ZnO particle (a) before and (b) after reaction in 5 mbar H_2O and with 6 W cm^{-2} light at 405nm wavelength.

References

1) Herrmann J-M 2005 Topics in Catalysis 34 49-65.
2) Gai PL 2003 ChemInform 34 161-173.
3) Tsujimoto M, Moriguchi S, Isoda S, Kobayashi T and Komatsu T 1999 Journal of Electron Microscopy 48 361-366.
4) Hansen TW, Wagner JB and Dunin-Borkowski RE 2010 Materials Science and Technology 26 1338-1344.