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Transmission electron microscopy characterization of photocatalysts for water splitting

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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 photodegradation of Cu₂O and the photodeposition of Pt onto a GaN:ZnO photocatalyst (Figure 1).

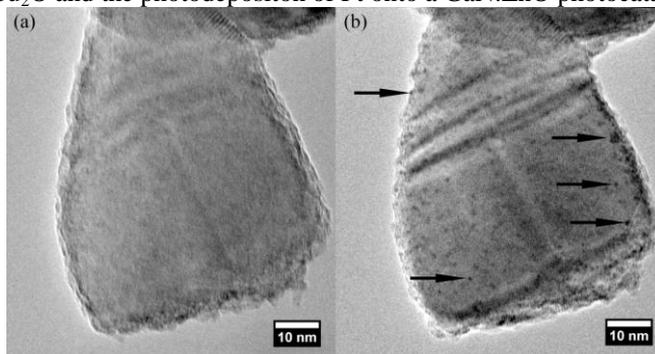


Figure 1: (a,b) Bright field TEM images of a GaN:ZnO particle (a) before and (b) after reaction in 5 mbar H₂O and with 6 W cm⁻² light at 405nm wavelength.

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