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Implementation of a light source in a TEM sample holder for *in situ* studies of photocatalytic materials

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Photocatalysts are of fundamental interest for sustainable energy research [1]. By means of transmission electron microscopy (TEM) it is possible to obtain insight into the structure, composition and reactivity of photocatalysts. Such insight can be used for their further optimization [2].

We have constructed a specimen holder capable of shining light onto samples inside the TEM. The holder contains a laser diode and an optical system that guides light onto a sample with maximum power transmission. The source can be changed and tuned, in principle spanning the whole visible and UV spectrum. The device can be used inside an environmental TEM (ETEM) allowing specimens to be analyzed during exposure to a controlled gas atmosphere and illumination.

The holder is presently being used to study a variety of photoreactive materials and structures, including photocatalysts, photonic devices and solar cells. For example, electron holography is being used to study p-n junctions both in the presence and in the absence of light in order to assess electron beam induced charging and discharging effects during laser light exposure [3].

Here, we present results from ETEM studies of light-induced phenomena that include metal nanoparticle photodeposition, light-driven particle discharging and photodegradation. We concentrate on phase transitions of Cu_2O nanocubes under visible light exposure in the presence of water vapor, which we study *in situ*. Cu_2O is an active photocatalyst for water splitting under visible light irradiation, but it undergoes photodegradation in an aqueous environment [4].

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