Approaching a comprehensive understanding of the photocatalytic activity of TiO_2 model catalysts

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(Photo)catalysis is believed to be the key-technology for solving major challenges of our time, e.g. cleaning air and water as well as producing green energy from solar light only.

Titanium dioxide – one of the most intensively studied model oxides – represents an important photocatalyst that is used for degrading toxic compounds and has the potential for producing hydrogen fuel from water. Titania is a wide band gap photocatalyst that is known to be sensitized to visible light by doping with foreign elements. Nonmetallic dopants have been found to be active in visible-light induced reactions. Transition metal doping has been reported to result in even more intense visible-light absorption [1, 2]. Doped titanium dioxide is a most promising model system for developing applications based on visible-light photocatalysis. Despite the number of recent publications, a comprehensive understanding of the dopant-induced changes of photocatatalytic properties is still to be accomplished. In fact, combining reactivity measurements with spectroscopic investigations and real-space imaging studies to characterize the visible-light absorbance, photocatalytic reactivity, surface structure and molecular adsorption characteristic at the same time is currently most essential.

The presented work focuses on the influence of transition-metal dopants, namely chromium and antimony, on the surface structure of TiO_2(110). Using Scanning-Probe Microscopy (SPM), we find the vacancy density created upon doping to depend strongly on the dopant ratio [3, 4]. This explains differences in photocatalytic reactivity. The surface roughness and the arrangement at the atomic scale give further insight into the implications of doping of this prototypical titanium dioxide surface. The study constitutes a step towards investigating more realistic, application-oriented systems using SPM for revealing detailed insights into the implications of transition-metal doping on the surface structure of the model-photocatalyst titanium dioxide.

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[2] T. Ikeda et al., J. Phys. Chem. C **112**, 1167 (2008).
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[4] R. Bechstein et al., J. Phys. Chem. C **113** 13199 (2009).