

Effect of light on mixed conducting electrodes in high-temperature solid oxide electrochemical cells

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The effect of light on electrochemical processes is often investigated in cells using a liquid electrolyte (e.g. [1]). Work on solid state photoelectrochemical cells, such as the theoretical study by Ye *et al.* [2], however, is scarce but fundamentally interesting and might hold some potential for future applications in sensor or energy storage technology.

From literature the response of the oxygen incorporation kinetics to the irradiation with UV light on the “model materials” SrTiO₃ [3] and TiO₂ [4] is known. These studies suggest that UV light accelerates the oxygen incorporation into the material after a sudden increase in the oxygen partial pressure of the surrounding atmosphere.

In the present contribution these two oxides were investigated under constant atmosphere to check the effect of light on (more or less) equilibrated samples. The two materials were used as electrodes in high-temperature solid state photoelectrochemical cells that were exposed to UV radiation while monitoring the voltage change or performing electrochemical impedance spectroscopy (EIS).

SrTiO₃ samples were prepared by depositing an yttria-stabilized zirconia (YSZ) thin film on single crystalline SrTiO₃. The SrTiO₃ single crystal served as a working electrode and was contacted *via* a grid-like Pt or Au current collector. On the TiO₂ samples the working electrode was a titania thin which was deposited on single crystalline YSZ by sputtering and subsequent annealing in air. Again, metal current collectors were used. The electrochemical cells were completed by a porous Pt counter electrode.

The voltage change upon irradiation with UV light was evaluated as a function of time and interpreted in defect chemical terms. The results were combined with those from EIS and suggest that apart from photovoltaic effects both materials seem to incorporate oxygen when irradiated with UV light. Accordingly, a battery-like voltage remains even after switching off UV light, indicating storage of chemical energy.

[1] Walter, M. G., Warren, E. L., McKone, J. R., Boettcher, S. W., Mi, Q., Santori, E. A., & Lewis, N. S. *Chemical Reviews* **2010**, 110, 6446-6473.

[2] Ye, X., Melas-Kyriazi, J., Feng, Z. A., Melosh, N. A., & Chueh, W. C. *Physical Chemistry Chemical Physics* **2013**, 15, 15459-15469.

[3] Merkle, R., De Souza, R. A. & Maier, J. *Angewandte Chemie International Edition* **2001**, 40, 2126-2129

[4] Gundlach, H. W. & Heusler, K. E. *Zeitschrift für Physikalische Chemie* **1980**, 119, 213-224.