Photovoltages in perovskite-type oxide thin film cells

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$SrTiO_3$ (STO), a perovskite-type oxide, shows many interesting effects under UV light irradiation, such as an increase in oxygen incorporation rate,[1] an enhancement in conductivity and a change in color in Fe doped STO single crystals.[2] The increased oxygen uptake under UV light has also been used for a battery-type voltage in STO under UV light irradiation.[3] With a top layer, e.g (La,Sr)CrO_3 (LSCr) much higher photovoltages can be reached.[4] Such high temperature solid oxide photovoltaic (PV) cells are promising due to their possible combination with solid oxide electrolyzer cells (SOEC). By using a common electrode of a PV cell and an underlying SOEC it is possible to directly transfer light to chemical energy. However, optimization of voltage and power of such high temperature PV cells is still required. In this study, different material combinations were tested for their applicability in oxide based perovskite solar cells.

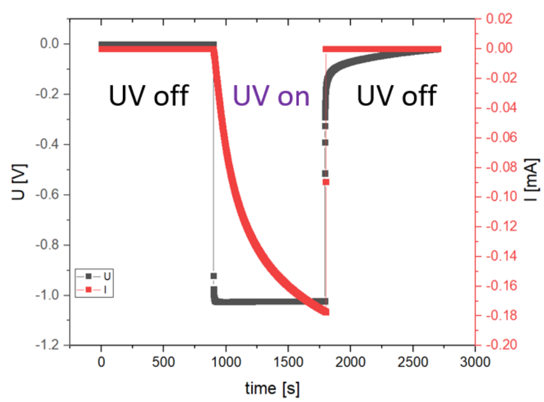

Figure 1: Voltage (black) and current (red) measurements under UV light of LSCr/STO.

The samples consisted of undoped $SrTiO_3$ substrates with (La,Sr)(Cr, Mn)O_3 (LSCrM) thin films on top. These lead to photovoltages as high as 1 V at 350 °C. In addition, other perovskite type oxides were also tested, such as (La,Sr)CoO_3 (LSC), (La,Sr)FeO_3 (LSF), $NdNiO_3$ (NNO) and even metals, such as Pt and Au. Optimization regarding film thickness and film preparation procedure was carried out to reach maximum performance and stability. In addition, a variation of the substrate (STO single crystal, STO polycrystal, Fe doped STO, Nb doped STO, TiO_2) revealed that undoped STO single crystals show the best performance.

For selected material combinations, a more detailed investigation has been carried out, including current measurements, temperature-dependent measurements, time-dependent measurements and in-situ Electrochemical Impedance Spectroscopy (EIS). By means of impedance spectroscopy, mechanistic insight in the processes under UV light can be gained.

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