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Visible light induced photochromism in Yttrium based oxy-hydrides

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Smart windows have the potential to contribute substantially to achieving energy neutrality of modern buildings. For this purpose the solar radiation towards and the thermal radiation emitted from the building, respectively, have to be controlled to maintain a certain temperature or illumination level under variable conditions in the course of the day and/or the seasons. Approaches to this challenge can be classified into static and dynamic technologies. In contrast to static solutions dynamic solutions including electrochromic, thermochromic, and photochromic materials offer the advantage of a flexible optical response to changing external conditions.
Electrochromic smart windows can be actively controlled but are based on a complex ‘battery-like’ stack of multiple thin film materials together with an external power supply . Photochromic materials have received less scientific attention as potential smart window coatings. This is partly because most photochromic materials react only to UV light or are organic compounds with limited lifetime that must be blended to achieve a color-neutral modulation of the visible light transmittance.
Recently, it was demonstrated that Yttrium-oxy-hydride (YO_xH_y) based thin films show a visible-light-induced color-neutral photochromic effect at ambient conditions . However, the material properties, performance limits and the nature of the reversible photochromic effect are not well understood. Therefore, we set out to investigate systematically the dynamic photochromic properties of YO_xH_y in correlation with its crystalline structure and chemical composition. Recent results of our approach that combines reactive magnetron sputter deposition with UV/VIS optical spectroscopy, X-ray scattering/absorption as well as ion beam analysis methods will be discussed. Despite the structural similarity between metallic Y-dihydride and YO_xH_y, the latter is found to be a wide band gap insulator where the photon energy threshold for the photochromic effect is given by the optical band gap. Further, cyclic illumination experiments suggest the presence of a previously unreported ‘memory effect’ that affects the photochromism dynamics even after complete optical relaxation of YO_xH_y without illumination.

Keywords
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