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Structural impact of Cr doping in titanium oxide thin films grown by co-sputtering and flash-lamp annealed

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Titanium dioxide (TiO_2) is used in many applications as a photocatalyst. However, TiO_2 activity is mostly limited to the UV spectral region due to its wide band-gap (~3eV). For this reason, many efforts[1] have been focused on band-gap narrowing to achieve visible-light (VISL) response in TiO_2, mostly by doping. Metal (cation) doping increases VISL absorption significantly but, unfortunately, it introduces structural distortions in the host matrix that result in a large number of defects acting as carrier recombination centers.[1] Post-processing thermal treatments are normally employed here to improve the structural order.[2] In this work, we study the impact of rapid non-contact thermal processes as flash-lamp annealing (FLA) on the electronic structure of Cr-doped TiO_2. For this purpose, (amorphous) thin films with different Cr contents were produced at room temperature by magnetron co-sputtering. The dopant concentration was quantified by Rutherford backscattering spectrometry (RBS) whereas the resulting structural phases after FLA were assessed by Raman and X-ray diffraction (XRD). Due to the disordered nature of the samples, the structural characterization has been complemented with local-order information around host and dopant sites from the X-ray near-edge structure (XANES). Finally, the optical properties have been studied by spectroscopic ellipsometry (SE). It is found that FLA can selectively tune the anatase/rutile phase formation in pure TiO_2. In addition, films with low doping (Cr < 6 at.%) display a rutile structure. For higher doping level, the formation of high-valence Cr sites is observed, which seems to be detrimental for the structural promotion. Nonetheless, these sites are thermally unstable and annihilated upon FLA. REFs: [1]Asahi et al. SCI 293, 269 (2001); [2]W. Zhu et al. PRL 103, 226401 (2009).

Keywords
Titanium oxide
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phase formation
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