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Electrical and optical properties of hydrogen- and niobium-doped TiO2 electrodes

Michael Weise, Rainald Mientus, Klaus Ellmer, Stefan Seeger

OUT e.V., Berlin, Germany

weise@out-ev.de

Hydrogen-doped titanium oxide (THO) and niobium-doped TiO_2 (TNO) films are of interest for various applications which require transparent conductive electrodes, i.e., photovoltaics [1], light emitting diodes [2], display technology [3], and solar water splitting devices [4]. The films were prepared by reactive magnetron sputtering from metallic targets (titanium and titanium-niobium alloys) as well as from ceramic targets (TiO_x and TiO_x:Nb) in different sputter gas mixtures (argon/oxygen, argon/oxygen/hydrogen, and argon/H_2O vapour) onto unheated substrates. The as-deposited films were amorphous, as shown by Raman spectroscopy and X-ray diffraction, and exhibited a high resistivity in the order of 10 to 10^5Ωcm. By a subsequent annealing in vacuum at 460 ˚C for 2 min, the films became polycrystalline with large crystallites (> 10 µm; anatase phase), accompanied by an increase of the optical transparence and the electrical conductivity. The niobium-doped as well as hydrogen-doped films on borosilicate glass stand out due to their low resistivities (≈1-6·10^{-3}Ω cm), high carrier mobilities (≈8-12 $cm^2V^{-1}s^{-1}$) and low optical absorption (k < 0.008)at a wavelength of 550 nm). In this study, the influence of the dopant element concentration (Nb, H) in polycrystalline anatase films on the electrical characteristics (Hall and conductivity measurements) as well as optical properties (UV/VIS/NIR) were investigated in detail.

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Keywords
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