

M-edges of X-ray absorption spectra of Er and Yb incorporated in TiO₂ thin films for up-conversion assisted water splitting into green hydrogen

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Titanium dioxide thin films are studied as the most promising electrode materials for green hydrogen generation in spite of the profound mismatch between their band gap and the solar spectrum [1]. A new strategy based on application of optically active materials containing lanthanide ions such as Er³⁺ and Yb³⁺ has been proposed [2]. Up-conversion from infrared to ultraviolet could in principle enhance light harvesting and improve solar-to-hydrogen efficiency provided that recombination of charge carriers remains controlled. X-ray absorption XAS measurements serve as a tool in the studies of incorporation of lanthanides into TiO₂. XAS spectra of transition metal oxides such as TiO₂ are well documented [3,4] while those of lanthanides M_{4,5} lines seem sparse [5]. The aim of this work is to present the correlation between XAS results and photocurrent vs. voltage characteristics of Photoelectrochemical Cells, PEC based on TiO₂:Er,Yb.

Thin films were prepared by rf reactive magnetron sputtering from metallic target in Ar+O₂ atmosphere of controlled oxygen and argon flow rates. Characterization techniques such as Scanning Electron Microscopy, SEM, X-ray diffraction, XRD, and optical spectrophotometry have been applied. XAS experiments were carried out at National Synchrotron Radiation Centre SOLARIS. The photocurrent vs. voltage curves were recorded in a home-built PEC.

XAS M-spectra of Er and Yb incorporated in TiO₂ thin films are shown in Fig.1. They can be accounted for by 3d-4f transitions typical for lanthanides. Even the smallest concentration of lanthanides of about 1 at.% can be easily detected by XAS. The best photocurrent vs. voltage characteristics is obtained for TiO₂ thin films with 1 at.% Er and 1 at.% Yb.

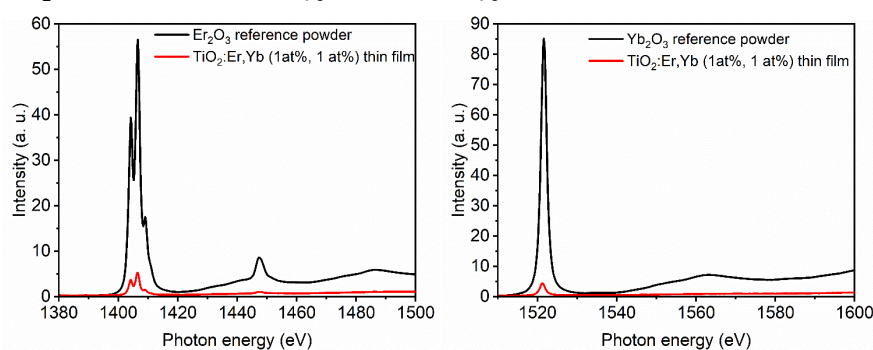


Figure 1. X-ray absorption spectra of Er and Yb M_{4,5} edges recorded for TiO₂:Er,Yb thin film (1 at.%, 1 at.%) in comparison to reference powders of Er₂O₃ and Yb₂O₃.

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