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Ferrite Spintronics

-Formation of p-n Junctions with Magnetic Oxide Semiconducting Heterostructures-

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The efficient use of solar energy is now one of the great challenges in science and technology. In these days, variety materials have been investigated for use as photo-anodes for water-splitting by sunlight. Among these materials, ferrite oxide such as Fe_2O_3 Fe_3O4 are regarded as a promising system because of their probabilities of bandgap engineering, which lie well within the visible-IR spectrum, as well as their low costs, electrochemical stabilities, and environmental compatibilities. Therefore, a considerable number of studies have been performed on the photoelectrochemical (PEC) properties ofα-Fe_2O_3.

We have demonstrated that enhanced photocurrent in Rh-substituted α-Fe_2O_3 thin films grown by a pulsed laser deposition. The Rh-substituted α-Fe_2O_3 ($Fe_{2-x}Rh_xO_3$; $0.0\leq x\leq 2.0$) thin films were grown on α-Al_2O_3(110) substrates with a Ta-doped SnO_2 electrode layer by pulsed laser deposition. Highly oriented epitaxial films with pure corundum structures were successfully fabricated over the entire compositional range. The optical absorption spectra of the films indicate narrowing of the bandgap with increasing Rh content. Consequently, the photoelectrochemical performance was improved in the Rh-substituted films. We found that the optimum Rh content lies at around x=0.2, where the photocurrent is significantly enhanced over a wavelength range of 340–850 nm. The bandgap of the films decreased with increasing Rh content. The PEC efficiency was significantly enhanced in the films with lower Rh contents, in the visible and NIR regions. The findings of this research are expected to be useful in the development of the solar fuel conversion systems based on alpha-Fe_2O_3.

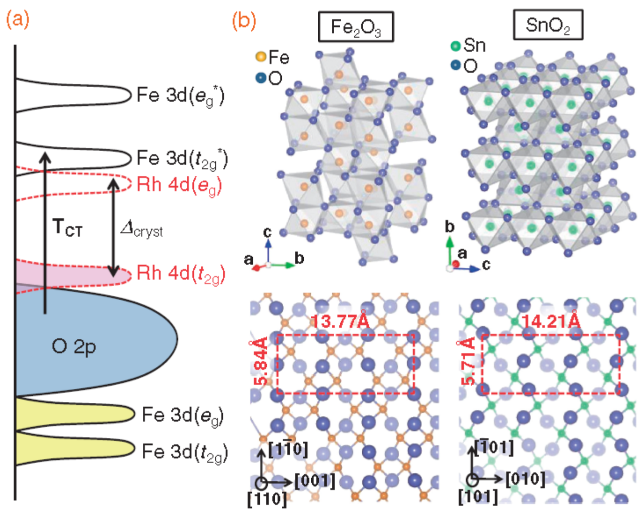

Fig.1 (a) Schematic of the band structure of $Fe_{2-x}Rh_xO_3$. TCT and ⊿cryst represent the charge transfer-type optical transition process and crystal field of Rh^{3+}, respectively. (b) Top: crystal structures of alpha-Fe_2O_3 (corundum type) and SnO_2 (rutile type). Bottom: schematic of the in-plane atomic configuration of alpha-Fe_2O_3 and SnO_2.

References
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