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Structural and optical properties of Er-doped TiO₂ thin films prepared by dual-frequency magnetron co-sputtering

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Abstract

Er-doped TiO₂ thin films have been prepared by dual-frequency magnetron co-sputtering with two targets composed of TiO₂ and Er₂O₃. The structural and optical properties of these thin films were investigated using various characterization techniques. X-ray photoelectron spectroscopy measurements show that the content of Er increases when the power on Er₂O₃ target increases. X-ray diffraction patterns indicate that the anatase TiO₂ peaks become weaker with the increasing power on Er₂O₃ target and the films tend to form amorphous structure. Scanning electron microscopy results show that the grain size decreases with the rise in Er content. UV-vis spectrophotometric analyses reveal that the values of band gap decrease from $3.35 \pm 1.3\%$ eV to $3.02 \pm 1.3\%$ eV with the increasing amount of Er from 0 at% to 3.2 at%. The red shift in the optical adsorption edge may contribute to a higher photocatalytic activity of TiO₂ thin films.

Keywords: Er-doped TiO₂ thin films; Dual-frequency magnetron co-sputtering; Band gap

1. Introduction

Titanium dioxide (TiO₂) thin films were extensively studied due to their applications in environmental fields such as self-cleaning of glasses and windows, water treatment, especially the photocatalytic degradation after ultraviolet (UV) light irradiation [1-10]. TiO₂ under UV radiation can disintegrate organic pollutants into carbon dioxide and water [4, 6, 9, 10, 29]. However, its low utilization of solar energy presents a strong drawback for its use in photocatalysis due to its large band gap energy of about 3.2 eV. Therefore, considerable attentions have been paid to extending the light response range of TiO₂ photocatalysts from UV to the visible domain.

The photocatalytic activity of TiO₂ under visible light can be enhanced by suitable doping [4-8,

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