Reactive magnetron sputtered $BiVO_4$ thin-film as an efficient visible light photocatalyst

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Abstract: Having strong photoactivity under visible light, $BiVO_4$ thin film is considered a great candidate to replace low efficient UV-active photocatalysts e.g. TiO_2, and to reduce recyclability and reusability problems of powder photocatalysts. In this research, $BiVO_4$ thin films were deposited on fused silica substrate using reactive magnetron sputtering employing metallic Bi and V targets, followed by a post-annealing treatment for 2 h at 450 ˚C, which is relatively high compared to Bi melting point (271 ˚C), to obtain nanoporous morphology based on Kirkendall effect. The thin films were characterized by X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), energy dispersive spectroscopy (EDS) and ultraviolet-visible-infrared spectroscopy (UV-Vis-IR). The XRD data showed that the as-deposited films were amorphous, and after the post-annealing treatment, the monoclinic scheelite $BiVO_4$ crystal structure was obtained. FESEM observations exhibited nanopores with an average diameter of 20-40 nm. UV-Vis spectrophotometry results proved light absorption in the visible region with a bandgap value of 2.45 eV. The thin film managed to photodegrade 80 % of Rhodamine-B solution after 7 h, showing the great photoactivity of $BiVO_4$ thin films. These results established that the combination of reactive magnetron sputtering and post-annealing treatment is an effective technique to produce nanoporous $BiVO_4$ thin films with great potential in photocatalysis for water treatment applications using solar energy.

Keywords: $BiVO_4$; Photocatalysis; Magnetron sputtering; Thin film; Nanoporous.

In the given graphical abstract a schematic of the reactive magnetron sputtering is presented, in which the deposition took place in a mixture of argon and oxygen at 4.5 Pa working pressure. Fused silica was used as substrate and it was rotated during the process to provide a homogenous deposition. The FESEM image shows nanopores on the film surface. The absorbance spectrum shows absorbption in the visible range and the inset Tauc plot shows the bandgap value of 2.45 eV. The photodegradation of Rhodamine-B solution was also measured to be around 80 % after 7 h of illumination under a 400 W light source equipped with a UV cut-off filter.