$In_2S_3/Bi_2WO_6/Fe_3O_4$ magnetic core-shell stucture as an efficient catalyst for sono-photo hybrid catalytic degradation of tetracycline

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Introduction. Recently, combinations of various advanced oxidation processes have been applied to treat detrimental compounds from wastewater. Sonophotocatalysis can manifest the high degradation of a broad domain of contaminants [1]. Bi_2WO_6 is an n-type, narrow band gap (2.8–3.0 eV) semiconductor. Despite its high photocatalytic activity, pristine Bi_2WO_6 is not ideal due to photo-induced rapid recombination [2]. In_2S_3 semiconductors possess a narrow band gap (1.8–2.3 eV), excellent visible light response, and a negative conduction band edge. However, its relatively slow carrier separation and migration kinetics make its catalytic performance unsatisfactory [3]. Additionally, magnetic supports could overcome the limitation of separation from the liquid phase, thus the catalyst could be effectively recycled by applying an external magnetic field [4]. Hence, in this study, the Z-scheme $In_2S_3/Bi_2WO_6/Fe_3O_4$ magnetic core-shell structure catalyst was prepared for sonophotocatalytic degradation of tetracycline (TC). The prepared catalyst was characterized by SEM, EDX, DRS, XRD, and XPS. In addition, the catalytic activity of the $In_2S_3/Bi_2WO_6/Fe_3O_4$ catalyst was investigated by sonophotocatalytic degradation of TC.

Results. The effects of $In_2S_3/Bi_2WO_6/Fe_3O_4$ and its components on the degradation efficiency of TC through sonophotocatalytic processes are shown in Figure 1. The 0.5 g/L of $In_2S_3/Bi_2WO_6/Fe_3O_4$ showed high degradation efficiency (95%) in solutions with pH = 6.5 of TC (10 mg/L) within 60 min, under visible LED light (75 W) and ultrasound irradiation (140 W). This high catalytic activity of the $In_2S_3/Bi_2WO_6/Fe_3O_4$ core-shell catalyst was mainly attributed to the synergistic effects of the formed interfaces between the shell and core, which generate an electric field to facilitate charge transfer and expand light absorption. Additionally, direct Z-scheme heterojunctions reduced the e^- and h^+ recombination. Furthermore, the results expressed the presence of synergy between the combined systems (sonocatalysis and photocatalysis). $In_2S_3/Bi_2WO_6/Fe_3O_4$ showed good reusability and stability.

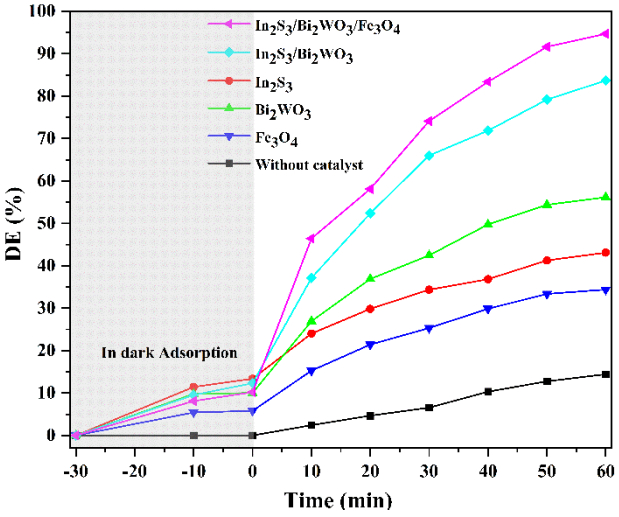

Figure 1. The degradation of TC in the presence of $In_2S_3/Bi_2WO_6/Fe_3O_4$ and its components

Keywords: Core-shell catalyst; Advanced oxidation processes; Bismuth tungstate; Indium sulfide; Tetracycline.

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