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Photodegradation of methylene blue catalyzed by tungstophosphate/aerogel hybrid materials under ultraviolet irradiation

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ABSTRACT

In this study, the tungstophosphates structural-family series (PW_9, P_2W_{12}, P_2W_{15}, P_2W_{18}, P_4W_{24}, P_5W_{30}, P_6W_{18}, and P_8W_{48}) were successfully immobilized onto silica aerogels (tetraethyl orthosilicate aerogel, TEOS) via a facile reaction method, under mild conditions. The chemical and structural properties of the prepared hybrid materials were assessed by various techniques such as Fourier transform infrared spectroscopy (FTIR), thermal gravimetric analysis, and X-ray diffraction. Additionally, FTIR, UV-visible (UV-Vis), Brunauer–Emmett–Teller, scanning electron microscopy, and energy-dispersive X-ray techniques eased our understanding for the loading of polyoxometalates (POMs) and their distributions onto the surface of silica aerogels. The most important analysis, in this study, is the nitrogen adsorption–desorption technique that showed a significant increase in the specific surface area and pore volume of the hybrid catalysts after the immobilization in comparison to the pristine POM counterparts, thus enhancing the probability of the surface-active sites. The photocatalytic activities of these photocatalysts were tested toward the cationic Methylene Blue dye model (MB) under ultra-violet light irradiation. The results obtained by UV-Vis and MS analyses confirmed that the MB can be removed by the prepared photocatalysts with maximum degradation efficiency of 75%–95% and 90%–98% in 120 min, for POMs and POM-TEOS hybrids, respectively.

Keywords: Polyoxometalates; Silica aerogels; Immobilization; Hybrid catalysts; Methylene Blue; Photocatalytic degradation

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