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Photocatalytic water purification: role of crystallinity, defects, surface area and hydroxyl ion concentration

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The presence of large number of industrial contaminants such as heavy metal ions Cr(VI), dyes and organic chemicals in water causing lung cancer, intestine cancer, kidney damage, asthma etc. [1-3]. Photocatalysis has been proved to be a capable method to remove water contaminants due to low cost, low energy consumption and regenerable solution [4-7]. Transition metal dichalcogenides (MoS_2, $MoSe_2$, WS_2, WSe_2) have enticed great attention due to special layered stable structure, high carrier mobility, direct bandgap, large surface area and controllable interfaces [8-10]. There are various methods to synthesize 2D nanostructures such as solvothermal, molecular beam epitaxy, electrochemical deposition, chemical vapour deposition etc. [13-16]. These methods are complicated or require high temperatures to operate. Hydrothermal is a simple, environment friendly and effective method to synthesize TMD's nanostructures and provides controlled growth rate, nucleation uniformity and it is suitable for large scale production. Photocatalytic degradation takes place at the interface between photocatalyst surface and pollutant, therefore it is expected that the photocatalytic activity is correlated with crystalline planes and surface structures. In this study, nanosheets and nanourchins of $MoSe_2$ were hydrothermally synthesized by varying the pH and comparative photocatalytic study on organic dyes (MB, MO) and heavy metal Cr(VI) were performed. Enhanced photocatalytic efficiency of nanosheets over nanourchins is correlated with crystallinity, enhanced surface area and hydroxyl ion concentration. Adsorption studies, role of reactive species, HPLC and regenerable properties of catalysts were also studied.