L.8: Photocatalytic degradation of dye solutions using Au-ZnO nanocomposites

Semiconductor-plasmonic nanocomposites exhibit efficient photo-catalytic activity due to their strong light absorption and charge separation properties in the composite form. One of the potential applications of these nanocomposites is photocatalytic degradation of harmful organic dyes for treatment of industrial effluents. The photocatalytic efficiency of the composites depends upon the crystalline quality of the semiconductor nanoparticles and also on loading ratio of Au nanoparticles. In this regard, crystalline ZnO semiconductor nanorods were synthesized in gram scale by hydrothermal method, followed by annealing at about 400 °C. Subsequently, Au nanoparticles were deposited on these nanorods through laser or light induced reduction of metal salts in solution phase.

Figure L.8.1 presents magnified view of the ZnO nanorods decorated with Au nanoparticles. The Au nanoparticles density on the nanorods were controlled by adjusting the Au salt concentration and light irradiation time.

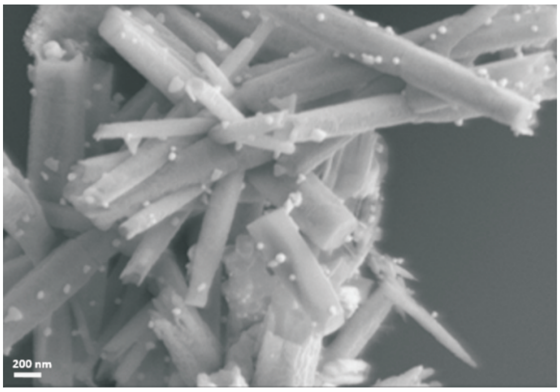

Fig. L.8.1: SEM image of ZnO nanorods decorated with Au nanoparticles.

Photo-catalytic response of these nanocomposites was studied through absorbance measurements of different dyes (methylene blue, methyl orange and rhodamine 6G) under UV lamp (~ 30 W) irradiation. Figure L.8.2 presents variation of methylene blue dye absorbance in the presence of photo-catalyst for different light irradiation time. Presence of dye molecules render its characteristic color in the solution which was monitored using UV-Vis fiber spectrograph. Complete disappearance of dye absorbance occurred after 70 min. of light irradiation and the inset figure presents the photograph of the dye solution before and after the light irradiation. In the absence of these nanocomposites, less than 10% reduction in dye absorbance was noticed for 4 hours of light irradiation. Significantly rapid degradation of the dye absorbance in presence of the nanocomposite confirms the photo-catalytic activity of the grown nano-composites. The dye degradation time was found to decrease with an increase in the concentration of nanocomposite in the dye solution.

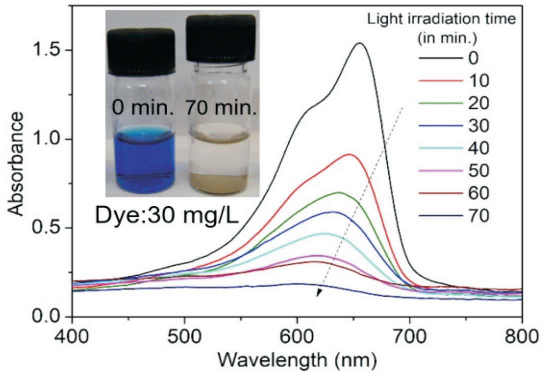

Fig. L.8.2: Variation of methylene blue dye absorbance for different light irradiation time (Inset: Colour of the dye solution, before and after light irradiation).

Typically, one gram of nano-composite loaded into one-litre dye (~ 40 mg/L) aqueous solution was found to be efficient for complete photo-degradation of the dye within 3 hours of light irradiation. Further the nanocomposites were also tested for de-coloration of textile industrial dye effluent which is shown in Figure L.8.3.

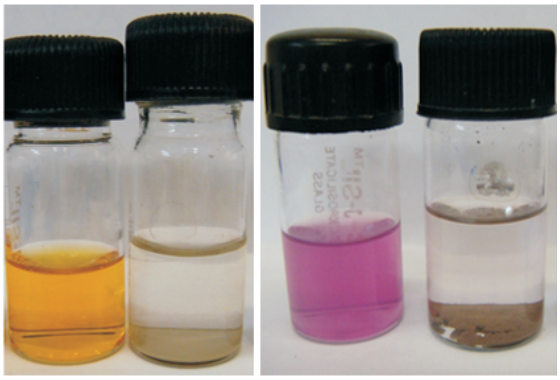

Fig. L.8.3: Photographs of (left) methyl orange dye and (right) textile industry dye effluent, before and after light irradiation in presence of nanocomposites.

The Au-ZnO nanocomposite catalyst may find important application towards treatment of effluents from textile and leather industries. The proposed method for synthesis of these nanocomposites is not only easily scalable for large scale production, but is also cost effective.

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