L.10: Visible active photocatalyst for solar light driven organic dyes degradation for water treatment

Visible active photocatalyst materials are promising for utilization of solar light for various chemical reactions including degradation of organic pollutants, fuel generation from CO_2, etc. The process is eco-friendly and energy efficient for treatment of colored effluents from different industries like textile, food and pharma. This photocatalytic dye degradation process is driven by various reactive radicals generated from photo-generated electron-hole pairs in semiconductor nanoparticles (NPs) i.e., photocatalyst. These radicals with high redox potentials degrade dye molecules, leading to de-coloration of water.

Visible active silver phosphate photocatalyst was prepared in different morphologies, by precipitation method. Figures L.10.1(a) and L.10.1(b) show random and tetragonal shaped silver phosphate NPs, respectively. The band gap of these NPs, as estimated from diffuse reflectance spectrum (Figure L.10.1(c)), is about 2.45 eV, reflecting their visible light photocatalytic activity. These NPs displayed cubic structure, as confirmed by x-ray diffraction (XRD) (Figure L.10.1(d)).

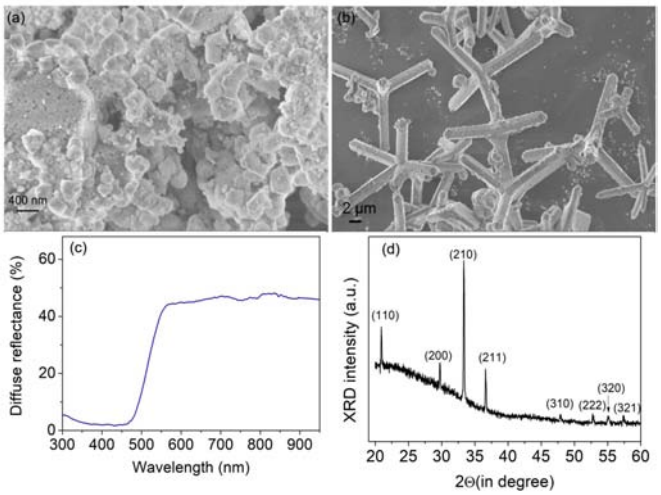

Fig. L.10.1: SEM images of (a) random, (b) tetragonal shaped silver phosphate NPs, (c) diffuse reflectance spectrum, and (d) XRD pattern.

The silver phosphate NPs were used for photocatalytic degradation of various kinds of dyes, including cationic, anionic and zwitterionic, of varied concentrations (1-50 µM). These solutions with photocatalyst loading of 1 g/L were exposed to solar light. Absorbance of dye solutions continuously decreased with irradiation time and color of the solutions of 10 µM and 50 µM dye concentration disappeared within 5 and 20 mins., respectively.

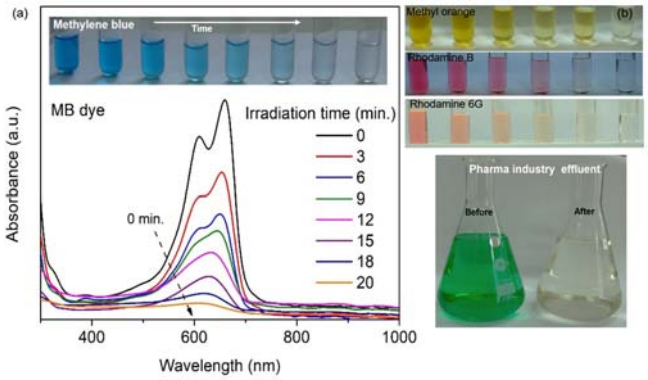

Fig. L.10.2: (a) *Variation of methylene blue dye absorbance at different light irradiation time* (*inset: photograph of the dye solution*), *and* (*b*) *photograph showing color removal of different dye and pharma effluent*.

Figure L.10.2(a) shows variation of absorbance and color of methylene blue dye with irradiation time. In order to study process kinetics and its optimization a software tool has also been developed in-house with the capability to analyze large number of UV visible spectra. The silver phosphate NPs were also tested for de-coloration of effluents from textile and pharmaceutical industries. Two hours of sun light irradiation in the presence of these NPs resulted in complete de-coloration (Figure L.10.2 (b)). Chemical oxygen demand (COD) measurements showed that the time required for complete mineralization of dye solution is longer than that required for its decoloration, which is governed by degradation rate constant of the dyes. Based on the results, a flowing water type sun light photocatalytic reactor has been designed and fabricated (Figure L.10.3). More tests are underway to evaluate stability of these NPs for multiple uses.

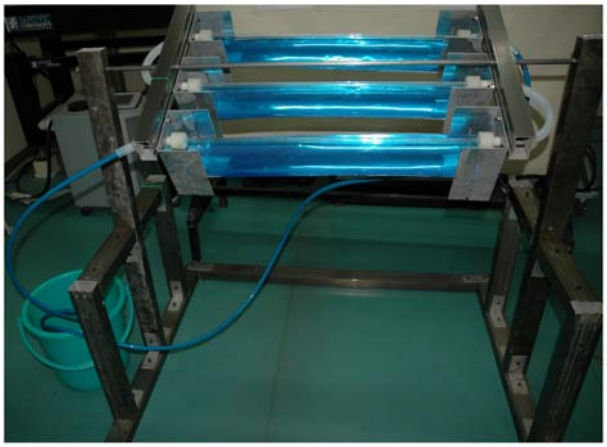

Fig. L.10.3: In-house developed photocatalytic reactor.

The results of the study demonstrate that visible active silver phosphate NPs are efficient photocatalyst for degradation of different dyes, their combinations and industrial effluents.

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