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Mesoporous Au/TiO_2 nanocomposite photocatalysts with enhanced UV and visible light photocatalytic activity

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Detoxification of harmful dyes through non-conventional catalytic processes is getting thrust in light of environmental remediation. Current work reveals synthesis of gold-titania (Au/TiO_2) mesoporous nanostructure and its photocatalytic performance for degradation of alizarin dye. Optically Au/TiO_2 shows a characteristic surface plasmonic absorption band at 520 nm, XRD pattern reveal the anatase phase of TiO_2 with fcc unit cell structure and tetragonal geometry. X-ray photon spectroscopy depicts (Au $4f_{7/2}$ at 84.0 and Au $4f_{5/2}$ at 87.7 eV) the elemental state of gold (Au^0). Specific surface area was witnessed to decrease with increase of Au content (169, 141, 130, 119 m^2/g for 1, 2, 3 and 4 wt% respectively). Au/TiO_2 nanocomposite showed higher catalytic performance in comparison to commercial TiO_2 (P25), this change is credited to better charge delocalisation at metal semiconductor interface.The reusability studies of the photocatalyst exhibited more than 98% degradation of the dye even after 10 consecutive cycles.

Dye pollutants are among the prime sources of water contamination from textile and printing industries. The treatment of these dye effluents is highly desired for the preservation of clean air, soil and water. There is an immediate need to take some necessary steps to develop efficient photocatalyst to degrade these toxic pollutants. Anatase phase of TiO_2 is one of the best photocatalyst for pollutant dye degradation. The importance of TiO_2 is selectively due to its low cost, good chemical and mechanical stability, high catalytic activity, non-toxic nature and strong metal-support interaction in TiO_2 supported catalysts [1]. Doping with metal or nonmetallic elements [2] or by deposition of noble metal nanoparticles (NPs) on TiO_2 surface is also an effective way to improve the photocatalytic activity of the catalyst [3]. Metal NPs loaded TiO_2 showed enhanced photocatalytic activity under UV or visible light irradiation.

Mesoporous TiO_2, as support material, shows a high efficiency due to its large surface area. However, there are great challenges in preparing mesoporous TiO_2 having large surface area and high crystallinity. It is well established that the catalytic activity of mesoporous TiO_2 supported gold NPs depends on the particle size, the nature of support and the preparation method.

In this respect herein, we have synthesized a series of Au/TiO_2 (different weight ratio of Au) nanocomposites by HDP method. This work has allowed us to draw clear conclusions regarding (i) the quantitative influence of particle composition; (ii) the role of particle size as well as surface area; and (iii) the influence of the support on photocatalytic activity. The structural features of Au/TiO_2 catalysts were investigated by XRD, CO-chemisorption, BET surface area, nitrogen adsorption-desorption and BJH pore size distribution, UV-Vis DRS, TEM, and XPS.

The main goal of our work was to synthesize different Au/TiO_2 composites using HDP method and to study their photocatalytic activity regarding degradation of alizarin red dye as model water pollutant under UV irradiation as well as sunlight. Also the effect of different Au/TiO_2 ratios on the photocatalytic activity and reusability was investigated (Figure 1).

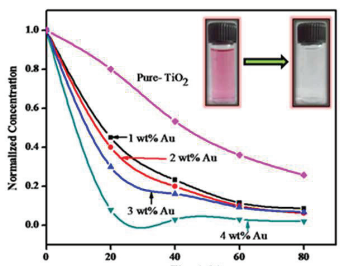

Figure 1: Kinetic variation towards alizarin photodegradation under sunlight on various Au/TiO_2 nanocomposites

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