# Novel Method in Incorporating Nanometals into$TiO_2$ Nanophotocatalyst with Enhanced Visible Light-Induced Photocatalytic Activity via Acid-Catalyzed Sonochemistry

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**Abstract**

In the search for efficient photocatalysts working under visible light, we have investigated the effect of metal ions (M: $In^{+3}$, $Cd^{+3}$, $Mo^{+3}$, $Ag^{+1}$, $Fe^{+3}$, $Co^{+3}$, $Ni^{+2}$, $Pb^{+2}$, $Cu^{+2}$) codoping on the photocatalytic activity of $TiO_2$ prepared by a simple developed route of ultransonic-assisted sol-gel (USSG) method. The transformation from anatase to rutile was suppressed by doping with metal atoms. Furthermore, the absorbance spectra of M@$TiO_2$ catalysts exhibited a significant red shift to the visible region. The intensity of photoluminescence (PL) spectra of M@$TiO_2$ catalysts decreased with the increase of the amount of implanted metal ions, indicating the decrease of electron–hole pair recombination. It was also observed that the lower the PL intensity of M@$TiO_2$ catalysts, the higher the photoactivity. The M@$TiO_2$ catalysts exhibited significant higher adsorption capacity for methyl orange (MO) than that of Degussa P25 and showed much higher visible-light-induced catalytic degradation for MO than that of P25. The high activities of the M@$TiO_2$ catalysts can be attributed to the results of the synergetic effects of strong absorption in the UV–Vis light region, red shift in adsorption edge, good crystallization, and delayed charge recombination. The USSG method adopted for the preparation of M@$TiO_2$ catalysts and the resultant highly photoactive $TiO_2$ make this investigation promising for various technological applications.

**Keywords**: Transition Metals; $TiO_2$; Doping; Photocatalytic Activity; Visible Light

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