

Title: Structural rearrangement of mesostructured silica nanoparticles incorporated with ZnO catalyst and its photoactivity: effect of alkaline aqueous electrolyte concentration

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Abstract: ZnO-incorporated mesostructured silica nanoparticles (MSN) catalysts (ZM) were prepared by the introduction of Zn ions into the framework of MSN via a simple electrochemical system in the presence of various concentrations of NH₄OH aqueous solution. The physicochemical properties of the catalysts were studied by XRD, ²⁹Si MAS NMR, nitrogen adsorption-desorption, FE-SEM, TEM, FTIR, and photoluminescence spectroscopy. Characterization results demonstrated that the alkaline aqueous electrolyte simply generated abundant silanol groups on the surface of the catalysts as a consequence of desilication to form the hierarchical-like structure of the MSN. Subsequent restructuring of the silica network by the creation of oxygen vacancies and formation of Si-O-Zn during the electrolysis, as well as formation of new Si-O-Si bonds during calcination seemed to be the main factors that enhanced the catalytic performance of photodecolorization of methyl orange. A ZM prepared in the presence of 1.0 M NH₄OH (ZM-1.0) was determined to be the most effective catalyst. The catalyst displays a higher first-order kinetics rate of $3.87 \times 10^{-1} \text{ h}^{-1}$ than unsupported ZnO ($1.13 \times 10^{-1} \text{ h}^{-1}$) that prepared under the same conditions in the absence of MSN. The experiment on effect of scavengers showed that hydroxyl radicals generated from the three main sources; reduced O₂ at the conduction band, decomposed water at the valence band and irradiated H₂O₂ in the solution, are key factors that influenced the reaction. It is also noted that the recycled ZM-1.0 catalyst maintained its activity up to five runs without serious catalyst deactivation.