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Characteristics of ZnO Synthesized by Combined Sol-Gel and Hydrothermal Methods for the Removal of Nitrobenzene

M. G. Liman[1*], A. H. Abdullah[2], M. Z. Hussein[3] and Z. Zainal[2]

1. Department of Pure and Applied Chemistry, Faculty of Science, Usmanu Danfodiyo University, Sokoto. **NIGERIA**
2. Department of Chemistry, Faculty of Science, Universiti Putra Malaysia, Selangor D. E.,**MALAYSIA**
3. Institute of Advanced Technology, Universiti Putra Malaysia, Selangor D. E., **MALAYSIA**

Email: gidado.liman@udusok.edu.ng

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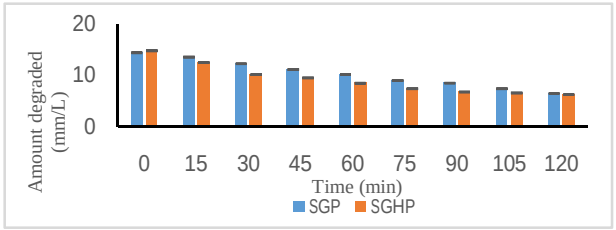
ABSTRACT

Ever-increasing world population and rapid industrial development across the globe is not without problem, especially in terms of availability of potable drinking water. The photocatalytic oxidation of zinc oxide, ZnO, under UV irradiation on organic pollutants in water is well established and nitrobenzene, NB, has been classified under persistent organic pollutants and reported as being carcinogenic.In this study, ZnO catalyst was synthesized via sol-gel method, SGP and for the first time via combination of sol-gel and hydrothermal method, in the presence of polyethylene glycol surfactant, SGHP. The resulting powder was calcined at 500^{0}C for a 2 hcalcination period. The prepared samples were characterized using X-ray Diffraction (XRD, Transmission Electron Microscopy (TEM), Field Emission Scanning Electron Microscopy (FESEM), Surface Area Measurement (BET method) and Diffuse Reflectance Spectroscopy (DRS). All the ZnO samples were spherical with hexagonal structure and particle size ranges from 16 to 96 nm. The photocatalytic activity of the prepared ZnO was evaluated by degradation of NB and 2h of UV light irradiation. ZnO prepared by a combined sol-gel and hydrothermal method, SGHP exhibits the highest photocatalytic activity (75% of NB removal) than SGP. This is attributed to high surface area and small particle size. The degradation of NB follows first-order reaction with a rate constant k_1 equals to 2.16 x 10^{-2} mgL^{-1} min^{-1} and a half-life period of 32 min.

Graphical Abstract



Degradation trend of NB by the ZnO samples synthesized using two different methods (Solgel and Solgel-Hydrothermal) for 2 h duration.

Keywords: Hydrothermal, Nitrobenzene, PEG, Photocatalyst, Nanoparticle, Sol-gel, Zno