

Nano-sized $\text{Ga}_{2-x}\text{Cu}_x\text{Zr}_{2-x}\text{W}_x\text{O}_7$ for Malachite green decolorization under visible light

Rabab A. Nasr^a, H.A. Abbas^{b,*}, Aya Khalaf^c, Ayat Bozeya^c, Tarek S. Jamil^a

^aWater Pollution Control Department, National Research Center, El Behouth Street, P.O. Box: 12622, Dokki, Cairo, Egypt, emails: rababelsheikh@yahoo.com (R.A. Nasr), omaytarek73@yahoo.com (T.S. Jamil)

^bInorganic Chemistry Department, National Research Centre, El-Behouth Street P.O. Box: 12622, Dokki, Cairo, Egypt, email: hu_abbas2005@yahoo.com (H.A. Abbas)

^cChemistry Department School of Science, The University of Jordan, Hamdi Mango Centre for Scientific Research, 11942, Amman, Jordan, emails: aya.khalaf89@yahoo.com (A. Khalaf), bozeyaayat@yahoo.com (A. Bozeya)

Received 15 May 2019; Accepted 6 December 2019

ABSTRACT

Novel nano-sized $\text{Ga}_{2-x}\text{Cu}_x\text{Zr}_{2-x}\text{W}_x\text{O}_7$ system was prepared using the Pechini method, where $x = 0, 0.05, 0.1$ and 0.15 . A single cubic fluorite phase was detected for all the prepared samples. The lattice parameter and unit cell volume of the undoped $\text{Ga}_2\text{Zr}_2\text{O}_7$ is higher than that of Cu, W co-doped $\text{Ga}_2\text{Zr}_2\text{O}_7$ samples. The band gap was decreased from 4.95 eV for the undoped $\text{Ga}_2\text{Zr}_2\text{O}_7$ to 2.89 eV for $\text{Ga}_{1.85}\text{Cu}_{0.15}\text{Zr}_{1.85}\text{W}_{0.15}\text{O}_7$ sample (15 mole % Cu and 15 mole % W doped $\text{Ga}_2\text{Zr}_2\text{O}_7$), shifting the absorption edge to the visible light area. The photocatalytic degradation efficiency of $\text{Ga}_{2-x}\text{Cu}_x\text{Zr}_{2-x}\text{W}_x\text{O}_7$ system for malachite green dye as a water contaminant model was presented. The photocatalytic activity of $\text{Ga}_{1.85}\text{Cu}_{0.15}\text{Zr}_{1.85}\text{W}_{0.15}\text{O}_7$ recorded 93.84% degradation of malachite green dye, which is higher than that of the undoped $\text{Ga}_2\text{Zr}_2\text{O}_7$ (16.66%). The photocatalytic degradation reaction for the malachite green dyes was inconsistent with the Pseudo-first-order kinetics model. The reusability of the prepared system as a catalyst was proven. The intermediates and the reaction pathways were detected by GC-MS.

Keywords: $\text{Ga}_2\text{Zr}_{2-x}\text{W}_x\text{O}_7$; Fluorite phase; Wastewater treatment; Nanomaterials; Malachite green dye

* Corresponding author.