Synthesis of a Novel Nanostructures From Zn-ZnO/MoS2 for Effective Removal of High-Concentration Dyes and Bacteria From Water Within a Record Time Alongside Green Hydrogen Production

Ghazi, Amr (School: EL-Shaheed-Oudah High School)

The contemporary era's heavy reliance on fossil fuels has exacerbated environmental degradation, particularly air and water pollution, necessitating a transition to sustainable options. Nanomaterials present a promising avenue for both energy production and water purification. Traditional photocatalysts, such as TiO2, faced limitations due to their inefficient UV light absorption caused by a wide bandgap. To address this challenge, a novel nanocomposite, Zn-ZnO/MoS2, has been engineered to efficiently utilize visible light for wastewater treatment and green hydrogen production, employing advanced techniques like pulsed laser ablation. Rigorous characterization via UV-Vis, XRD, TEM, DLS, AFM, and BET analyses has verified its effectiveness. Varied MoS2 concentrations in Zn-ZnO/MoS2 composites have notably narrowed the ZnO bandgap to 2.6 eV, enhancing visible light activation. Material coupling has led to a reduction in electron-hole pair recombination rates, resulting in a 65% improvement in specific surface area, Which led to a change in the mechanism of action of our compound in removing organic pollutants from photocatalysis to adsorption. The composite has demonstrated superior electrocatalytic potential in water splitting compared to IrO2, achieving a remarkable 61% enhancement in performance at 1.5 V and significantly 80000 times lower production costs. Moreover, it exhibits exceptional efficiency in organic pollutant removal, achieving a staggering 99% adsorption rate on Iodine blue dye within just 5 minutes, coupled with potent antibacterial properties. This versatile material holds promise for green energy production, antibacterial applications, and wastewater treatment.