1.1. Materials

The precursors zinc acetate [$Zn(CH_3COO)_2.2H_2O$], sodium hydroxide (NaOH), crystal water containing tin chloride ($SnCl_4.5H_2O$), sodium sulfide (Na_2S), dysprosium oxide (Dy_2O_3), and ethanol-like solvents of analytical grade (99.9% in purity) are procured from Merck, for the synthesis of ZnO/SnS and Dy-doped ZnO/SnS nanocomposites. Deionised water is used for dilution.

1.2. Characterizations

X-ray diffraction (XRD) data were collected using a Cu-K radiation source and an XPert Pro PAN analytical diffractometer ($\lambda = 0.15406$ nm). Using HITACHI H-7650 equipment with an accelerating voltage of 120 kV, TEM micrographs were captured. Samples of powder were dissolved in an ethanol solution. The homogeneous dispersion was then dropped onto a copper grid that had been coated with carbon, where it was allowed to cure before being analysed. To ascertain the oxidation states of the component elements in the sample, an XPS analysis was performed using a Thermo Scientific K-alpha surface analysis device. To ascertain the energy bandgap, DRS spectra in the wavelength range of 200–900 nm were captured using a JASCO V-670 spectrophotometer. An HIPR-MP400UV-vis annular-type photo reactor was used to investigate the photocatalytic dye degradation. Furthermore, software used for the data analysis of various techniques are Xpert HighScorrer plus for XD, DigitalMicrograph for TEM, XPSPEAK4.1 for XPS, Thermo Scientific VISIONlite5 for UV-DRS, and Cary WinUV for photocatalytic analysis.

1.3. Photocatalytic experimental process

At room temperature, MB aqueous solutions were exposed to visible light. An HIPR-MP400UV-vis annular-type photo reactor was used to investigate the dye's photocatalytic breakdown. For each sample, 100 mL of a 10 ppm· MB aqueous solution and 10 mg of produced catalyst (Dy-doped ZnO/SnS) were combined. To maintain the adsorption/desorption equilibrium between MB and the catalyst before light illumination, the solution was magnetically agitated in the dark for one hour. The resulting formulation was then exposed to sun radiation. A UV-vis-NIR spectrophotometer was used to analyze the degradation of MB dye in 5 mL aliquots taken from the solution. Each experiment was conducted twice: once under standard conditions (using only MB) and once with catalytic material (ZSD). The MB dye aqueous solution is collected for investigation just prior to the light illumination to measure the initial concentration of dye (C_0). The curve C/C_0 versus the illumination time (t) is drawn to derive the first order kinetics of the reaction. The MB dye degradation is correlated with the absorption and intensity fluctuation of the main band at 663 nm in the presence of visible light illumination.