SYNTHESIS AND CHARACTERIZATION OF PHOTOACTIVITY ENHANCED FLAKE-LIKE B_2O_3 - ZRO_2 NANOCOMPOSITES: A POTENTIAL APPLICATION FROM SRI LANKAN MINERAL SANDS

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Organic dyes, pigments and coatings are extensively used in chemical industry. Due to the expansion of dye, paint and pigment manufacturing industries, pollution of fresh water bodies takes place at an alarming rate. Photocatalytic degradation of industrial dyes has attracted much scientific interest recently owing to its convenience over alternative methods including adsorption and microbial degradation. Zirconia (ZrO_2) is an inert, chemically stable and widely used engineering material which is available in Sri Lankan mineral sands. Despite its wide availability, use of it as a photocatalyst has been limited due to the wide optical band gap energy. Further, in its pristine form, it is less efficient than popular Anatase and ZnO. In this study, we attempted to improve the bandgap energy of ZrO_2 by doping Boron via an in-situ composite synthesis resulting in a nanocomposite with enhanced photocatalytic activity. A convenient ethanol/water based sol-gel approach was utilized in the synthesis with $ZrOCl_2$ and H_3BO_3 as precursors. NH_4OH was used to increase the pH in the nanocomposite precipitation step followed by a calcination step at 750 °C. A novel flake-like morphology was observed in the nanocomposite while the particle dimensions were approximately 200 x 200 x 75 nm. The nanocomposite was characterized by XRD, SEM, TEM FT-IR and UV-Vis spectroscopy. The novel nanocomposite exhibited a distinct monoclinic phase as opposed to predominant tetragonal phase of pristine ZrO_2. Optical bandgap energy had reduced from 4.55 eV to 3.51 eV for direct allowed electronic transitions. As photocatalytic performance was assessed by Methylene Blue (MB) dye degradation efficiency, the novel nanocomposite was able to reduce the MB concentration by 81.7 % while pristine ZrO_2 could reduce only 36 % after 60 minutes of UV irradiation. The synthesized nanocomposite is simple in synthesis and possesses significant photocatalytic potential to be used in degradation of industrial dyes and other environmentally detrimental organic compounds. In addition, owing to the inherent refractory nature of ZrO_2, it holds promise as a durable hard coating in the development of self-cleaning materials.

Keywords: *photocatalytic degradation, novel nanocomposites, optical band gap*