BISMUTH-BASED LAYERED COMPOUNDS AS PHOTOCATALYSTS FOR ENVIRONMENTAL APPLICATION

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Bismuth-based semiconductors are regarded as promising photocatalytic materials due to their suitable band gap for visible light absorption, increased mobility of photogenerated charge carriers because of well-dispersed Bi 6s orbital, non-toxicity, and easy tailoring of their morphologies owing to their layered structure. In this study, we have explored a wide variety of bismuth-based semiconductors, namely Bi_2O_3, Bi_2MO_6 (M = Mo, W), $BiVO_4$, BiOX (X = Cl, Br, and I) and $(BiO)_2CO_3$ for environmental remediation. As a narrow band gap semiconductor, Bi_2O_3 has five polymorphs: α-Bi_2O_3 (monoclinic), β-Bi_2O_3 (tetragonal), γ-Bi_2O_3 (body-centered cubic), δ-Bi_2O_3 (cubic), and ω-Bi_2O_3 (triclinic). Among them, β-Bi_2O_3 has the strongest absorption in the visible light region with a smaller band gap (E_g = 2.0–2.4 eV) and demonstrated a good photocatalytic performance than other polymorphs under visible light irradiation, and is inexpensive, nontoxic, and stable in acidic conditions. To further enhance its photocatalytic performance, β-Bi_2O_3 was composited with MoS2 quantum dots and Pd/PdO nanoparticles, and doped with Gd^{3+} ions. Also, the $(BiO)_2CO_3/Fe_3O_4$, $(BiO)_2CO_3/Bi_2O_3$, and $(BiO)_2CO_3$/Ag/AgBr composites were synthesized to enhance the visible light absorption and improve photocatalytic performance for the degradation of various organic pollutants under visible light. The present work demonstrated that the bismuth-based photocatalytic nanomaterials have potential to be applied in wastewater treatment and air purification systems in the future.

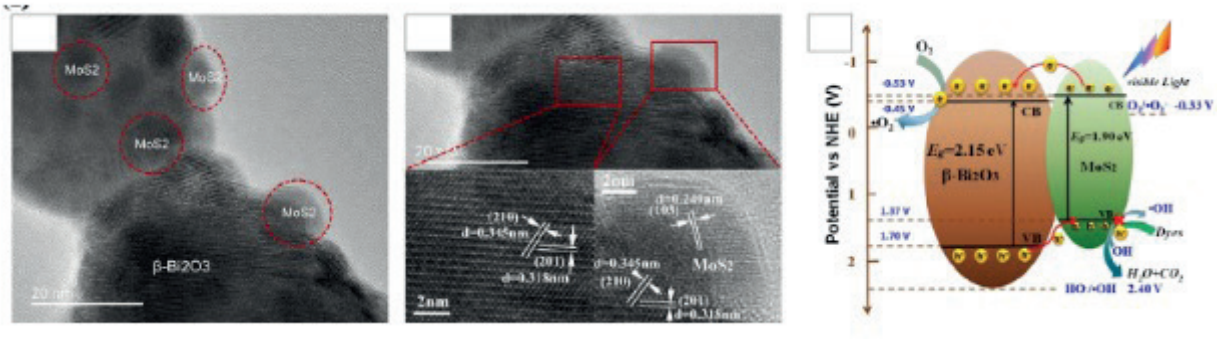

Figure 1. (a,b) TEM images of β-Bi_2O_3 particles loaded with 1.0% MoS_2 and (c) a schematic diagram of the photocatalytic mechanism and the photogenerated charge transfer process in MoS_2/β-Bi_2O_3.