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Single step combustion synthesis, characterization and photocatalytic application of α -Fe₂O₃-Bi₂S₃ heterojunctions for efficient and selective reduction of structurally diverse nitroarenes

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ABSTRACT

A series of α -Fe₂O₃-Bi₂S₃ heterojunction materials were prepared by a one-step autocombustion method employing thiourea as fuel. The heterojunction materials were characterized using XRD, UV-Vis-DRS, FTIR, PL, XPS, FESEM, TEM and HRTEM analytical techniques. XRD study indicated presence of rhombohedral α -Fe₂O₃ and orthorhombic Bi₂S₃ in the heterojunction materials. The heterojunctions displayed better optical absorption in the visible region and enhanced charge carrier separation characteristics. The oxidation state of the constituent elements on the surface was established from XPS study. IR study showed the characteristic vibrational features of both α -Fe₂O₃ and Bi₂S₃ phases. Microscopic studies indicated presence of well dispersed α -Fe₂O₃ nanorods in a continuous Bi₂S₃ matrix. The α -Fe₂O₃ nanorods were typically 30-50 nm in diameter and 120-150 nm in length growing isotopically in different direction from a single nucleation point. The calculated band positions of both components indicated a facile electrons transfer from the conduction band of α -Fe₂O₃ to Bi₂S₃ whereas migration of holes occurs in the reverse direction yielding a type-II heterojunction. The α -Fe₂O₃-Bi₂S₃ heterojunctions materials were evaluated as selective and efficient photocatalyst for the hydrogen transfer reduction of nitroarenes under visible light illumination. Structurally diverse nitroarenes could be selectively reduced to the corresponding amines in high yield and purity using α -Fe₂O₃-Bi₂S₃ as photocatalyst.

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