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PII: S1385-8947(17)30075-X
DOI: http://dx.doi.org/10.1016/j.cej.2017.01.075
Reference: CEJ 16377

To appear in: *Chemical Engineering Journal*

Received Date: 24 September 2016
Revised Date: 19 December 2016
Accepted Date: 18 January 2017

Please cite this article as: Y.P. Bhoi, B.G. Mishra, Single step combustion synthesis, characterization and photocatalytic application of α-Fe_2O_3-Bi_2S_3 heterojunctions for efficient and selective reduction of structurally diverse nitroarenes, *Chemical Engineering Journal* (2017), doi: http://dx.doi.org/10.1016/j.cej.2017.01.075

Single step combustion synthesis, characterization and photocatalytic application of α-Fe_2O_3-Bi_2S_3 heterojunctions for efficient and selective reduction of structurally diverse nitroarenes

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ABSTRACT

A series of α-Fe_2O_3-Bi_2S_3 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-Fe_2O_3 and orthorhombic Bi_2S_3 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-Fe_2O_3 and Bi_2S_3 phases. Microscopic studies indicated presence of well dispersed α-Fe_2O_3 nanorods in a continuous Bi_2S_3 matrix. The α-Fe_2O_3 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-Fe_2O_3 to Bi_2S_3 whereas migration of holes occurs in the reverse direction yielding a type-II heterojunction. The α-Fe_2O_3-Bi_2S_3 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-Fe_2O_3-Bi_2S_3 as photocatalyst.