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Photocatalytic degradation of alachlor using Type-II CuS/$BiFeO_3$ heterojunctions as novel photocatalyst under visible light irradiation

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ABSTRACT

In this study, a sustainable visible light promoted photocatalytic route has been developed for mineralization of alachlor pesticide using CuS/$BiFeO_3$ heterojunction materials. The heterojunctions were synthesized by a two-step process and characterized using XRD, FESEM, HRTEM, XPS, FTIR, UV-Vis-DRS and PL techniques. Morphologically, the heterojunction materials consist of $BiFeO_3$ nanoplates with high aspect ratio and CuS nanorods. The intimate contact between the two phases was ascertained from the HRTEM study. Optical property study suggested that these materials show excellent absorption in visible region with superior charge carrier separation characteristics compared to the individual components. The transient photocurrent measurement and I-V plots revealed high mobility of the excitons across grain boundary due to heterojunction formation. The band positions of the two components were aligned favourably for a cyclic movement of electrons and holes resulting in a type-II heterojunctions. The CuS/$BiFeO_3$ materials efficiently catalyse the mineralization of alachlor pesticide under visible light illumination achieving > 95% degradation within 60 min. The mechanism of alachlor degradation over the catalyst surface was elucidated using GCMS and radical scavenger experiments. The attractive features of the developed photocatalytic method are the use of renewable energy, low cost, high efficiency, stability and recyclability of the catalyst material.

Keywords: Pesticide, Bismuth ferrite, Copper sulfide, Photocatalytic degradation, XPS

1. Introduction

A variety of synthetic chemicals are used in agricultural sector as fertilizers, growth hormones and pesticides to boost productivity to cater to the need of increasing population. Among them, the pesticides are regarded as major water pollutants because of their adverse environmental and health effects. The unintended consumption of pesticides causes severe health effect like cancer, cardiovascular, reproductive and neurological disorders in non-targeted animals including humans [1, 2]. Alachlor is one of the widely used pesticides from chloroacetanilide family used to control