Environmental remediation of aqueous cyanide by photocatalytic oxidation using a NiFe$_2$O$_4$/TiO$_2$–SiO$_2$ core–shell nanocomposite

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ABSTRACT

A core–shell NiFe$_2$O$_4$/SiO$_2$–TiO$_2$ nanocomposite photocatalyst was prepared in a three-stage manner. The NiFe$_2$O$_4$ core was prepared by applying an organic precursor method. This core was coated with SiO$_2$ and then with TiO$_2$. The optimum preparation conditions were determined by examining various molar ratios of Si, Ti, ethanol, and ammonia. X-ray powder diffraction, DR-UV, TEM, and magnetization techniques were used to characterize the nanocomposite. Using molar ratios of SiO$_2$/NiFe$_2$O$_4$ = 0.03, ethanol/NiFe$_2$O$_4$ = 20, ammonia/NiFe$_2$O$_4$ = 1, and Ti/ethanol = 0.8, a magnetic photocatalyst of enhanced properties was synthesized. A surface area of 520 m$^2$/g, saturation magnetization value of 53.2 amu/g, coercivity of 500.0 Oe, and a band gap of 2.54 eV were observed for the synthesized NiFe$_2$O$_4$/SiO$_2$–TiO$_2$ nanocomposite photocatalyst. These characteristics allowed excellent photodegradation of the toxic cyanide ion. In addition, the strong magnetic properties allow for the efficient reuse of the catalyst.

Keywords: Core–shell; Visible photocatalyst; Cyanide