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Efficient Reduction of 4-Nitrophenol to 4-Aminophenol using Ag/ α -Ti(HPO₄)₂ as a Catalyst

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Abstract

4-aminophenol (4-AP) is an important precursor material in industry that is involved in the manufacture of dyes, photographic developers, corrosion inhibitor, hair-dyeing agent, and antipyretic drugs. Therefore, efficient and cheaper methods for the hydrogenation of 4-nitrophenol (4-NP) to 4-AP using heterogeneous catalysts have been subjected to many research attempts. Ag nanoparticles (AgNPs) anchored on various solid supports have been utilized to lower the tendency for agglomeration. These heterostructure nanomaterials used as catalysts have shown promising results on many organic reactions. A simple hydrothermal method was developed for the synthesis of AgNPs anchored on α -titanium bismonohydrogen orthophosphate monohydrate Ag/ α -Ti(HPO₄)₂H₂O (Ag/ α -TiP). The prepared nanoparticles (NPs) were characterized by using the X-ray diffraction (XRD) method, high-resolution transmission electron microscopy (HRTEM), energy dispersive X-ray analysis (EDX), and X-ray fluorescence. TEM images show a successful incorporation of AgNPs on to the α -TiP support. The chemical reduction of 4-NP to 4-AP was carried out using NaBH₄ in the presence of α -TiP, and Ag/ α -TiP. Ag/ α -TiP showed the highest catalytic and photocatalytic activity on the 4-NP reduction compared to α -TiP. Catalytic experiment on the reduction of 4-NP using Ag/ α -TiP and under light conditions showed the fastest rate with a half-life of 6.71 minutes compared to α -TiP. Further, Ag/ α -TiP catalyst showed good reusability maintaining over 80% efficiency over three cycles.

Keywords: Silver nanoparticles, 4-aminophenol, α -TiP