Degradation of Rhodamine B under Visible-Light with Nanotubular Ag@AgCl@AgI Photocatalysts

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Abstract

In recent years, AgX (X=Br, Cl or I) materials have been confirmed as unique and efficient visible-light photocatalysts for degradation of several dye pollutants. Therefore, in this study, heterostructured Ag@AgCl@AgI nanotubes were synthesized via an anion-exchange reaction between Ag@AgCl nanotubes and I^- anions. Moreover, their photocatalytic performance towards the decontamination of dye contaminants were examined. These prepared photocatalysts were accordingly characterized using high-resolution scanning electron microscopy (HR-SEM), XRPD, XPS, field-emission transmission electron microscopy (FE-TEM), and photoluminescence (PL) spectroscopy. XANES spectra of Ag atom in AI-X (X=0, 1, 2, 3, and 4) samples exhibited pre-edge absorbance peak (Ag = 25, 514 eV), which is a feature of Ag. The structural identification analyses confirmed that the photocatalysts had nanotubular morphology. Compared to polyhedral Ag@AgBI nanocomposites, the amalgamation of I^- ions into the Ag@AgCl framework extraordinarily improved the photocatalytic performance. The synthesized Ag@AgCl@AgI nanotubes can also be reused due to their high stability. Under visible-light irradiation, >91.8% of Rhodamine B (RhB) was degraded within 45 min using the catalyst AI–2 (Cl^-/I^- = 1:1). The radical trap experiments indicated that the photodegradation of RhB was driven by the participation of superoxide radical and the action of holes. Due to the surface plasmon resonance effect, the photocatalyst AI–2 demonstrated higher photocatalytic performance, enhanced surface area and photoelectron transfer, which is also ascribed to its unique heterostructured configuration.

Keywords – Ag@AgCl@AgI nanocomposite; heterostructured nanotube; photocatalysis; dye photodegradation; XANES/EXAFS.

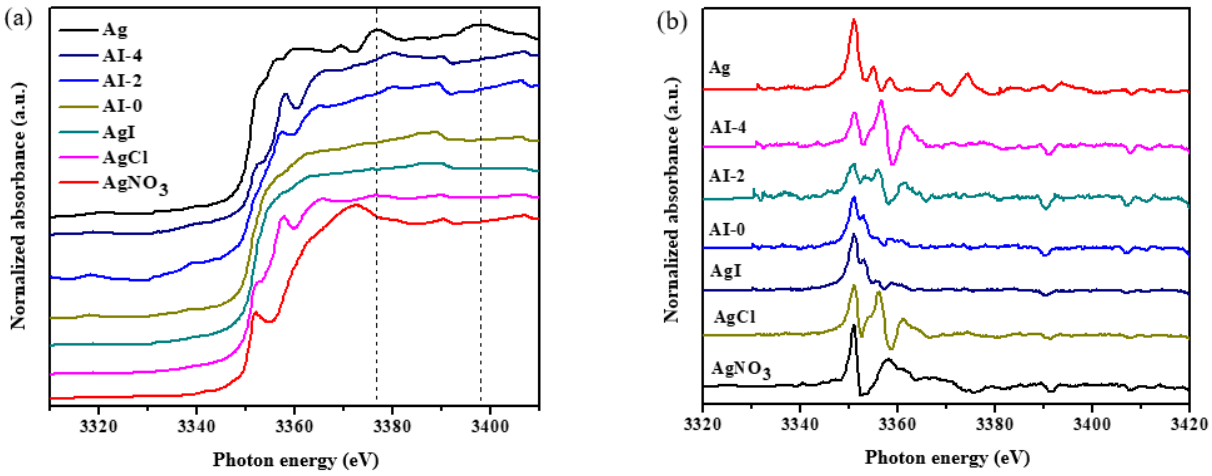

Figure. (a) Comparison of the Ag L3-edge XANES spectra of the different samples; (b) Derivative XANES spectra of Ag, AgCl, AgI, AI-0 (Cl: I = 0:1), AI-2 (Cl: I = 1:1), AI-4 (Cl: I = 9:1).