A novel $CuNaTi_3O_8$ Freudenbergite-type photocatalyst for efficient water purification under visible light irradiation

Panagiotis Tzevelekidis[a], and Christiana A. Mitsopoulou[a]

[a]*Laboratory of Inorganic Chemistry, Department of Chemistry, National and Kapodistrian University of Athens, Zografou GR-15771, Greece*
e-mail: patzeve@chem.uoa.gr

In the field of heterogeneous photocatalysis, TiO_2 nanoparticles occupy a prominent position. Nevertheless, the main drawbacks of TiO_2, - specifically, its inability to absorb visible light and the rapid recombination of excitons - overshadow its great advantages, such as chemical stability and low toxicity, thereby limiting its uses as a widely used photocatalyst [1]. Recently, composite materials based on the modification of the crystal structure of titanium dioxide have garnered interest in photocatalysis. The framework of TiO_2 can accommodate cations such as Na^+, leading to sodium titanate, a material with interesting optical ad physical properties. To maintain charge balance, other cations, such as Fe^{3+}, Cr^{3+}, and Ni^{2+}, can also be incorporated into the lattice, resulting in Freudenbergite ($FeNaTi_3O_8$)- like structures that exhibit intriguing physical and optical properties [2], [3].

Herein, we report the synthesis of a novel $CuNaTi_3O_8$ nanoparticulate semiconductor through sol-gel chemistry. Several techniques have been employed to characterize this new material including powder X-ray diffraction (XRD), electron microscopy (SEM, TEM), dynamic light scattering (DLS), IR-ATR, UV-Vis, and Raman spectroscopies. The photocatalytic performance of this material was systematically evaluated under visible light irradiation using low-energy LED lamps, demonstrating significant degradation of Methylene Blue and Rhodamine B dyes. To elucidate the underlying photocatalytic mechanism, scavengers such as isopropanol (IPA), ethylenediaminetetraacetic acid (EDTA), and sodium sulfate (Na_2SO_4) were utilized to identify the active species involved in the degradation process. These findings highlight the potential of $CuNaTi_3O_8$ as an efficient photocatalyst for water purification under visible light conditions.

References:

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