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Recent progress of Ag/TiO_2 photocatalyst for wastewater treatment: Doping, co-doping, and green materials functionalization

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ABSTRACT

Surface modification via doping or functionalization is one of the most commonly applied approaches for addressing the innate limitations of TiO_2 photocatalysts. Amongst numerous dopants, silver (Ag) has been regarded as an efficient strategy to retard electron holes recombination due to the formation of the Schottky barrier on the TiO_2 interface and extending absorption to the visible region. This review primarily focuses on discussing and evaluating the recent progress in the modification of Ag/TiO_2 via co-doping with non-metals and transition metals, as well as the synthesis strategies that have been applied in engineering the materials. The effects of doping and co-doping on the induced chemical and physical properties, photocatalytic performance, stability, and recyclability aspects have also been highlighted. This review also examines the potential improvement of Ag/TiO_2 through the addition of green materials such as plant-based materials (cellulose-derived composites, chitosan, alginate), ceramic materials (clay, kaolin bentonite), and also ionic liquid green solvent. Recommendations for further research opportunities, limitations, and challenges have also been suggested.

1. Introduction

Nanostructured semiconductors have been regarded as promising materials for environmental remediation due to their high photocatalytic oxidation property when it is activated under ultraviolet (UV) radiation which accounts for only 5% of the solar spectrum. Although physical methods (e.g. adsorption), biological methods, chemical precipitation, and membrane filtration have all been applied for wastewater treatment, they pose various limitations such as membrane fouling, high elimination of pollutants compared to other advanced oxidation processes (AOPs) such as Fenton, chemical oxidation, ozonation, and sonolysis due to its numerous advantages. The photocatalytic oxidation process can be initiated at normal pressure and temperature by highly reactive oxidative species, particularly hydroxyl radicals [3,4]. Amongst various semiconductors applied for environmental remediation, titanium dioxide, TiO_2 is regarded as an important photocatalyst due to its excellent activity under the UV spectrum which makes it an efficient photocatalyst since its oxidation state may change without experiencing