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Promoting the photocatalytic reduction of CO_2 and dye degradation via multi metallic Sm_x modified $CuCo_2O_4$ Reverse spinel hybrid catalyst

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ABSTRACT

Structuring a multi-functional photocatalyst of which enable high visible light harnessing so as to address the environmental pollution issues is the need of the hour. In view of this, a combination of catalytically active Cu, Co with enhanced adsorption capacity and Sm dopant that can enrich the catalyst with the defect centres would result in a tailor-made photocatalyst. Samarium (Sm) (1–12 wt %) doped $CuCo_2O_4$ were synthesized by simple precipitation route. The synergistic influence of Sm, Cu and Co on the photocatalytic ability has been ascertained by optical, structural and morphological methods like XRD, BET, SEM, XPS, Photocurrent, PL, ESR, fluorescence quenching, NMR methods. Thus prepared catalyst was utilized for the photo-catalytic mineralization of methylene blue and reaction was optimized and also it has been proven robust for the photo-reduction of CO_2 into value added products, which are identified by NMR spectral analysis. A comprehensive mechanism has been suggested based on the experimental results. The present research provides the concept of multi-functional photo-catalyst for effluent decontamination and CO_2 reduction.

1. Introduction

A new kind of functional materials also known as multifunctional materials with unique properties that can reduce human work load and improve life style by virtue of their increased efficiency, reliability, chemical stability and scalability [1–3]. Synthetic protocol for the converting of CO_2 to value added products of commercial importance to address the critical energy and environmental issues [4]. Till date, many photo-catalysts based on titania [5], bismuth [6], carbon [7,8], vanadium [9] and tungsten [10] have been explored for effluent degradation, fuel production and CO_2 photo-reduction. Among all the metal-catalysts explored in this field, copper and cobalt based catalysts are shown to be potential candidates due to their higher affinity towards the adsorption of CO_2 [11,12]. Also presence of rare earth Sm^{3+} ions in the material will push the conduction levels towards further negative value and high basic nature of rare earth ions would boost the adsorption kinetics of CO_2 over the surface the material [13,14]. Further, these rare earth ions provide high thermal stability [15], leads to the development of high oxygen vacancy defects [16], improved visible light assimilation capacity [17]. Also, owing to the impartation of enhanced photo-physical characteristics by these rare earth ions like better quantum efficacy and higher retention of photo-stimulated electrons [18–20], as Sm^{+3} ions possess complex energy level pattern (^6H_J and ^6F_J multiplets) the excited level includes emissions from $^4G_{5/2}$ transitions. Also, Sm^{3+} facilitates fast oxygen mobility and boosts catalytic properties due to the existence of $^4f_5$ electronic configuration [21]. Fluorescence can be observed in

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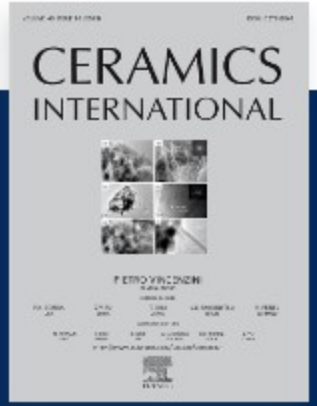

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