

Photocatalytic Degradation of Polyethylene Microplastics Using Microwave-Activated Gadolinium Oxide Catalyst

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Abstract: The persistent presence of polyethylene (PE) microplastics in aquatic environments poses serious environmental and health risks due to their resistance to conventional degradation methods. This study explores the photocatalytic degradation of PE microplastics using microwave-activated gadolinium oxide (Gd_2O_3) under visible light irradiation. Key operational parameters, including pH solution, catalyst dosage, and initial PE concentration were systematically investigated. Optimal degradation efficiency (68%) was achieved at pH 7, a catalyst dosage of 3 g/L, and a PE concentration of 10 mg/L. Kinetic analysis indicated that the degradation followed a pseudo-first-order model, with a maximum apparent rate constant (K_{app}) of 0.0103 min^{-1} ($R^2 = 0.9782$). The degradation mechanism was further elucidated using the Langmuir–Hinshelwood kinetic model, suggesting a surface-mediated reaction with a high adsorption equilibrium constant (K_{LH}) of 0.4896 L/mg, indicating strong PE adsorption. The reduced degradation efficiency at higher PE concentrations was attributed to the limited generation of reactive oxygen species and increased light scattering. Overall, the findings demonstrate Gd_2O_3 's potential as an efficient, environmentally benign photocatalyst, contributing significantly to the development of rare-earth-based materials for sustainable microplastic remediation in water treatment technologies.

Keywords: gadolinium oxide; microwave-assisted; photodegradation; advanced oxidation process; polyethylene microplastics

■ INTRODUCTION

The widespread contamination of aquatic environments by microplastics has emerged as a critical

global concern. Among various polymeric microplastics, polyethylene (PE) is the most frequently detected due to its extensive use in packaging, household products, and