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Development And Characterization Of A Cu-Mg-Ce Metal Oxide Composite For Efficient Degradation Of DMMP

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The threat posed by chemical warfare agents (CWAs), particularly nerve agents, necessitates ongoing development of effective decontamination solutions. Traditional protective equipment, primarily reliant on adsorbents, faces limitations due to finite adsorption capacities, highlighting the need for materials capable of decomposing CWAs into non-toxic products. Dimethyl methylphosphonate (DMMP), a simulant for G-series nerve agents such as sarin (GB), serves as a model compound in research due to its structural similarity, featuring a pivotal (P=O) bond.

Herein, we report the synthesis of a novel Cu-Mg-Ce-based metal oxide (CMC) composite material crafted via a sol-gel combustion-assisted method to form mesoporous beads. This material was engineered to catalytically decompose DMMP into non-toxic byproducts including formates, carbonates, phosphate compounds, carbon monoxide (CO), and carbon dioxide (CO2). Morphological and chemical analyses were conducted using 77K N2 Brunauer-Emmett-Teller (BET), H2-Temperature Programmed Reduction (TPR), X-ray Photoelectron Spectroscopy (XPS), and Infrared Diffuse Reflectance Fourier Transform Spectroscopy (IR DRIFTS). Our findings confirm the presence of Cu in both Cu+ and Cu2+ oxidation states and reveal an abundance of OH groups at the Cu and Mg interface, facilitating the adsorption and subsequent decomposition of DMMP. Additional DRIFTS analysis post-CO adsorption indicated the formation of adsorbed formate, CO, and CO2, confirming the reactive nature of the CMC surface. These results underscore the potential of the CMC composite as a promising candidate for the degradation of DMMP, providing valuable insights into broader applications for CWA decontamination.

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