Holey Graphene-Integrated $NiTiO_3/TiO_2$ Heterojunction Photocatalyst for Efficient Degradation of Antibiotics in Hospital Wastewater and Development of Self-Cleaning Photocatalytic Membranes

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Abstract

Antibiotics are widely used in healthcare, agriculture, and animal husbandry, contributing to their increased presence in water sources through wastewater, agricultural runoff, and improper disposal. This leads to antibiotic-resistant bacteria and poses risks to both ecosystems and human health. Hospital wastewater, in particular, contains antibiotics, amplifying these threats. Photocatalytic membrane reactors (PMRs), which combine photocatalysis and membrane filtration, offer a promising solution to address this issue. This study focuses on synthesizing HGN-$NiTiO_3/TiO_2$ nanocomposites by integrating $NiTiO_3/TiO_2$ with holey graphene (HGN). These nanocomposites demonstrate effective photocatalytic degradation of antibiotics when exposed to light. Additionally, mixed matrix membranes (MMMs) were developed using varying HGN-$NiTiO_3/TiO_2$ loadings to optimize the membranes' performance. The membranes showed an asymmetric porous structure, enhancing water flux, antifouling properties, and photocatalytic efficiency. The best results were achieved with a 2 wt.% HGN-$NiTiO_3/TiO_2$ membrane, demonstrating excellent antifouling and antibiotic degradation performance. Hybrid ultrafiltration membranes with self-cleaning and photocatalytic properties were also fabricated using the optimal nanocomposite, showing effective self-cleaning ability and enhanced photocatalytic efficiency in decomposing antibiotic solutions. These findings highlight the potential of HGN-$NiTiO_3/TiO_2$-based membranes in PMRs for effective hospital wastewater treatment and antibiotic removal.

Figures

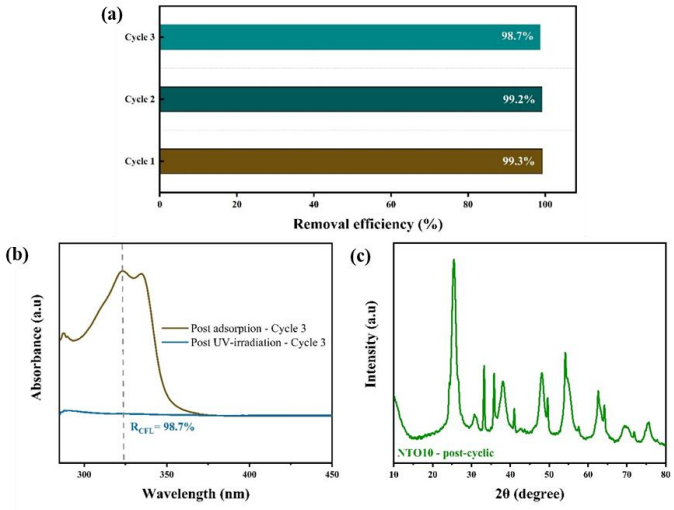

Figure 1: (a) Cyclic efficiency for NTO 10, (b) UV absorbance spectra and (c) XRD pattern for NTO10 post-cyclic study.