SYNTHESIS OF ADVANCED FUNCTIONAL MATERIALS FOR 3D LITHOGRAPHY

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Climate change and rapid urbanization pose growing challenges to ensuring safe drinking water. Hundreds of thousands of people still rely on surface water sources, highlighting the urgent need for efficient and environmentally friendly water disinfection technologies. Photocatalysis, particularly solar-driven disinfection (SODIS), has emerged as a promising solution. However, the development of durable and highly active photocatalytic materials remains a significant challenge. This study aimed to fabricate hexagonal boron nitride (h-BN) semiconductor 3D photocatalysts using UV lithography and to evaluate their applicability for solar-light-driven water disinfection. The research sought to determine how structural design and thermal treatment influence photocatalytic efficiency.

Various 3D photocatalyst structures were fabricated using an Original Prusa SL1S Speed 3D printer from a prepared photopolymer resin containing h-BN microparticles. Refractive index measurements confirmed that the prepared resin's optical feature fell within the range of standard photopolymer resins. To increase surface area and improve material properties, the printed objects were pyrolyzed for 3 hours at 900 °C in a nitrogen atmosphere. Fourier-transform infrared spectroscopy (FTIR) analysis of the annealed structures revealed characteristic h-BN peaks, confirming the retention of h-BN after pyrolysis. Photocatalytic performance was evaluated by monitoring the degradation of Rhodamine B dye under a halogen lamp simulating solar irradiation. Reaction rate constants were calculated from the obtained absorption curves. Selected structures were also tested for reusability and compared with non-pyrolyzed samples.

The results demonstrated that pyrolyzed h-BN 3D structures exhibited significantly higher photocatalytic activity compared to non-pyrolyzed samples. Among structurally stable samples, the diamond lattice structure showed the most efficient Rhodamine B degradation. Reusability tests indicated that h-BN photocatalysts could be reused, although with slightly reduced efficiency in subsequent cycles. Non-pyrolyzed structures were capable of dye degradation but exhibited substantially slower reaction rates.

The study demonstrates that 3D-printed boron nitride structures are promising photocatalysts for solar-driven water disinfection, particularly after pyrolysis treatment. Structural design and thermal processing significantly influence photocatalytic efficiency, suggesting strong potential for further optimization and application in sustainable water treatment technologies.

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