Investigation of Customizable Radiation Shielding Materials: DLP 3D Printed Boron-doped Polymer Composites

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Radiation shielding is essential to reduce the biological, technological and environmental risks associated with radiation exposure. Recently, Digital Light Processing (DLP) 3D printing has gained increasing attention as a flexible and rapidly expanding additive manufacturing technique, offering the capability to produce customized, lightweight protective components using UV-curable resins combined with high-resolution and functional additives. In this study, the potential of boron-rich polymer composites fabricated via DLP 3D printing as advanced radiation shielding materials was investigated.

Colemanite, a naturally occurring boron mineral, was doped into a photopolymer resin at concentrations of 0, 1, 2, and 5 wt% to enhance its radiation attenuation performance. Radiation shielding measurements of the colemanite-doped composites were performed against 356, 662, 1173, and 1333 keV gamma energies using a NaI(Tl) detector. The results demonstrated that increasing the colemanite content significantly improved gamma-ray absorption performance.

In addition to radiation shielding, the morphological and mechanical properties of the produced composites were examined through XRD, SEM, and EDX analyses. The findings revealed that colemanite-doped composites produced via DLP 3D printing exhibited effective radiation shielding performance, highlighting their potential for modern protective applications.