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FABRICATION OF 3D BORON CARBIDE BY COMBINING STEREOLITHOGRAPHY AND PYROLYSIS

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Additive manufacturing-based 3D printing is a groundbreaking technology that is rapidly gaining traction in the industrial sector. It opens up exciting opportunities for creating diverse structures or complete devices in a significantly shorter timeframe, reducing the duration from conceptualization to the production of the final physical object. The use of homogenous photoactive materials in 3D printing is favored for achieving enhanced properties, ensuring a consistent composition and uniform characteristics in the printed objects. This uniformity contributes to enhanced structural integrity, increased mechanical strength, and the attainment of a smoother surface for the structures. In contrast, the inclusion of particles in a monomer mixture may introduce variability, potentially compromising the quality of the print and the structural uniformity.

Boron carbide stands out as a promising material for numerous technical applications owing to its exceptional properties. This material boasts desirable characteristics such as low density, high strength, excellent wear resistance, exceptional hardness, and chemical inertness [1]. As a result, the focus here is on synthesizing organoboron compounds and subsequently forming them by combining stereolithography with pyrolysis to create intricate and precisely shaped 3D objects of boron carbide.

Initially, a boron-containing organic monomer, namely 2-(5,5-dimethyl-1,3,2-dioxaborinan-2-yloxy)ethylmethacrylate (referred to as boron methacrylate monomer), was synthesized through an esterification reaction detailed in article [2]. Verification of successful synthesis was confirmed through proton nuclear magnetic resonance analysis (see fig. 1. a)), showcasing a product yield of approximately 60%. Subsequently, utilizing ultraviolet three-dimensional printing, structures of boron acrylate polymer were crafted (see fig. 1. b)), followed by pyrolysis at 1300^{o}C in an N_2 atmosphere, resulting in a measured shrinkage of 60%. Furthermore, X-ray diffraction analysis (XRD) of the final product will be presented to confirm the formation of the crystalline.

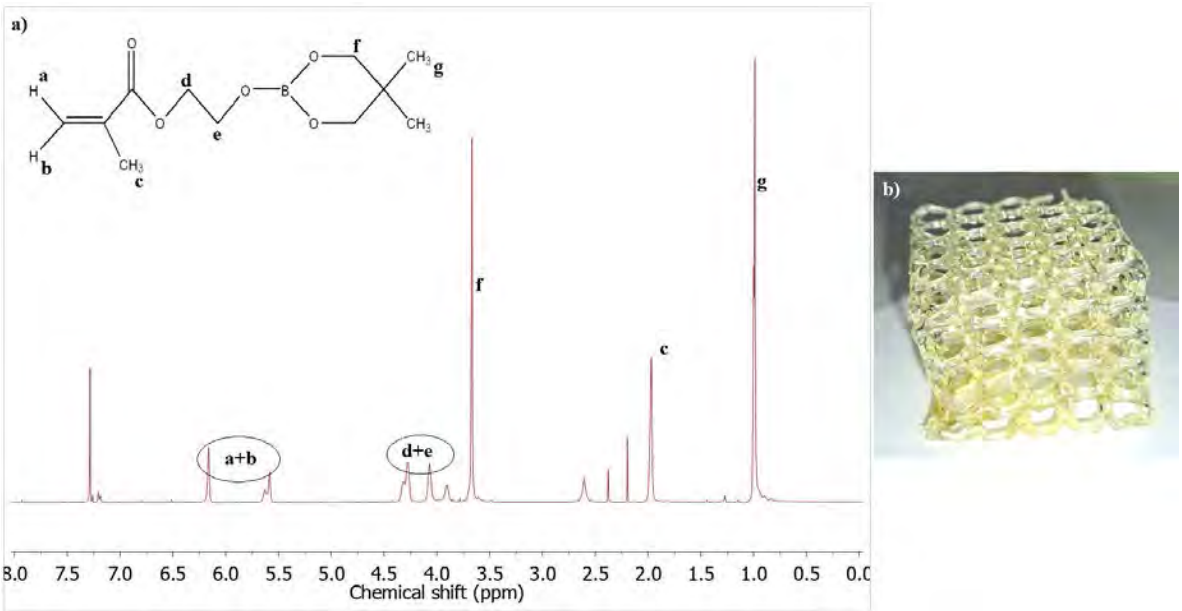

Fig. 1. a) ^{1}H-NMR spectra of boron methacrylate monomer in $CDCl_3$, b) Image of boron methacrylate polymer.

The integration of organoboron acrylate synthesis, 3D stereolithography, and pyrolysis has been emerged as a promising method for creating small, intricately detailed structures made of boron carbide. The suggested viable solution for crystalline boron carbide 3D printing at the microscale has the potential to significantly enhance the range of tools available in the printing industry.

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