

ABSTRACT - POSTER

Closing the Loop in Ceramic Additive Manufacturing: Thermal Recycling of Hydroxyapatite Green Parts for Stereolithography Bone Scaffold

J. PARISIS, A. SCHRIJNEMAKERS*, R. CLOOTS**

**GREENMAT, CESAM Research Unit, Institute of Chemistry B6, University of Liège, 4000, Liège, Belgium*

Abstract

Hydroxyapatite (HA) is one of the most widely used bioceramics for bone tissue engineering owing to its chemical similarity to the mineral phase of natural bone, as well as its excellent biocompatibility and osteoconductive properties. Vat-photopolymerization processes, such as stereolithography, enable the fabrication of complex and patient-specific HA-based scaffolds. However, the increasing adoption of these technologies generates waste streams, including defective green bodies, for which no dedicated recycling strategy has yet been established.

This study investigates the recovery and reuse of HA powder extracted from non-conforming stereolithography green parts through thermal treatment. A calcination-based process was developed to remove the organic resin phase and recover the ceramic fraction. The recovered powder was characterized and compared with virgin HA and thermally treated virgin HA using particle size analysis, structural and morphological characterization, and optical measurements.

To assess its potential for reuse in additive manufacturing, the recovered powder was reformulated into photopolymerizable suspensions and evaluated through rheological and photopolymerization analyses. Its behavior was systematically compared with that of reference formulations prepared from virgin HA powder.

The results demonstrate that thermal treatment effectively recovers high-purity hydroxyapatite while preserving the key physicochemical properties required for stereolithography processing. Furthermore, formulations prepared with recycled powder exhibit rheological and curing characteristics compatible with additive manufacturing requirements. These findings demonstrate the feasibility of reintegrating recovered HA powder into the production cycle of stereolithography-based bone scaffolds and represent an important step toward more sustainable and circular manufacturing approaches for advanced bioceramic materials.