3D PRINTING OF BIOBASED PHOTOCURABLE CERAMIC SLURRIES PREPARED WITH SECOND-LIFE GLASS-BASED MATERIALS

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INTRODUCTION

Stereolithography-based 3D printing enables the fabrication of advanced ceramic components with high precision[1].

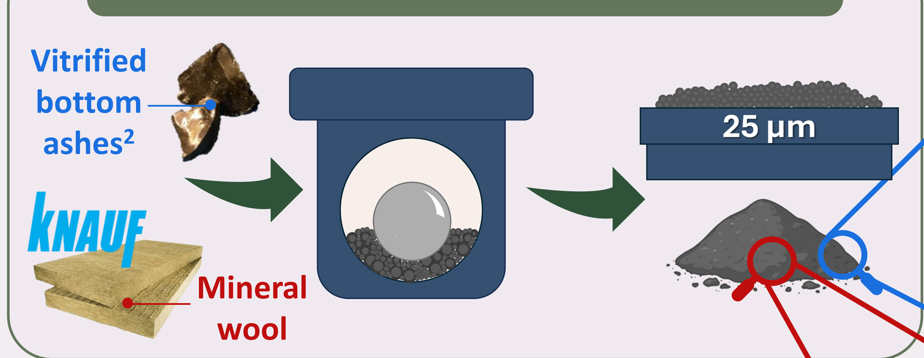
These techniques make it possible to create complex shapes which are not achievable with conventional methods.

This hybrid method reduces production time and material waste compared to traditional ceramic processing.

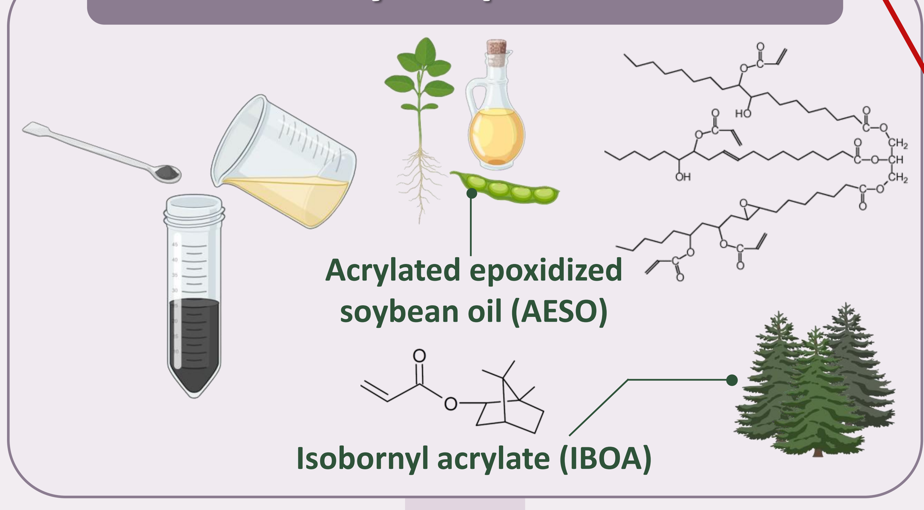
Slurry formulation requires optimized viscosity and controlled photopolymerization for printability.

MATERIALS & METHODS

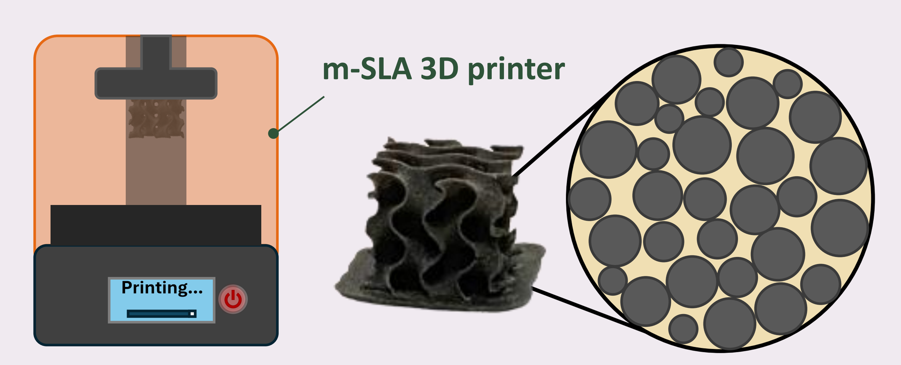
Milling & Sieving



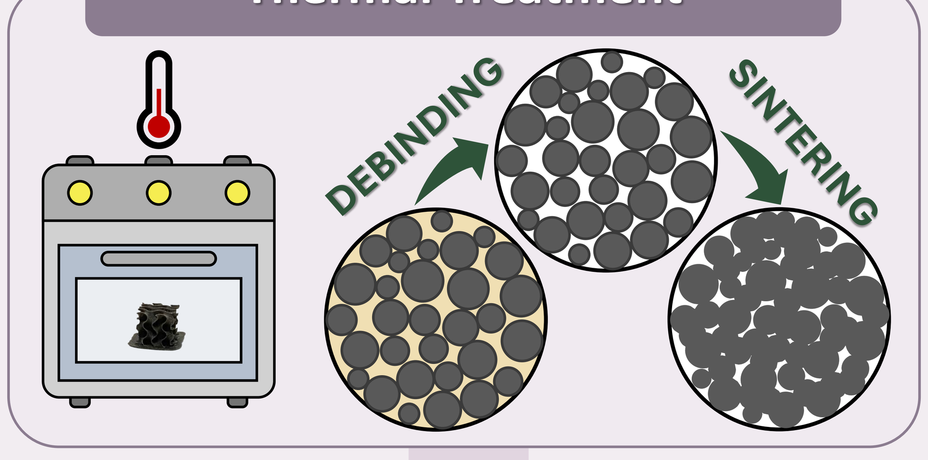
Slurry Preparation

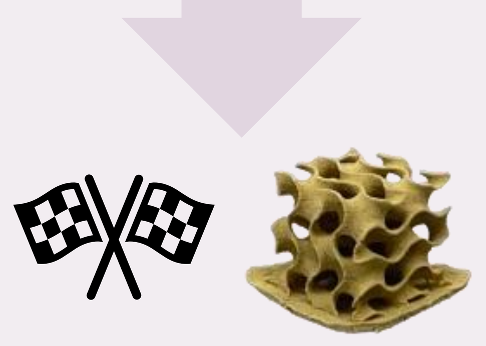


3D Printing

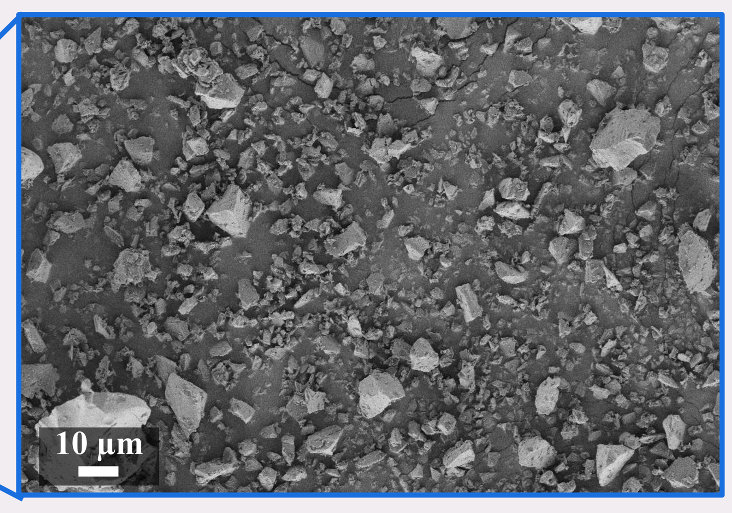


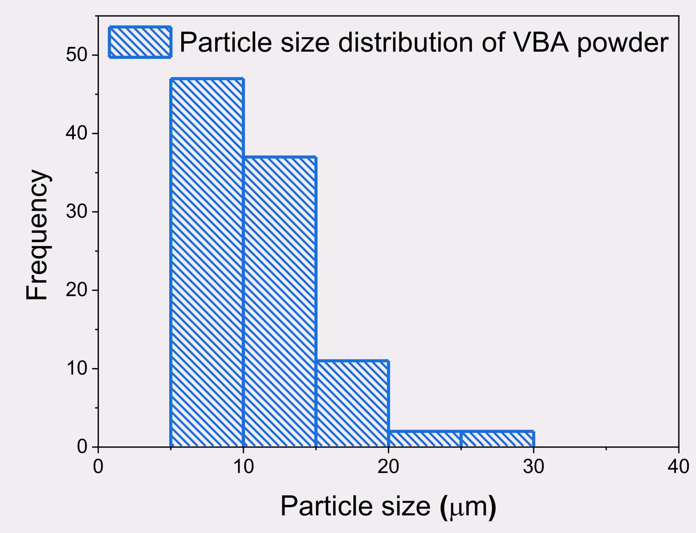
Thermal Treatment



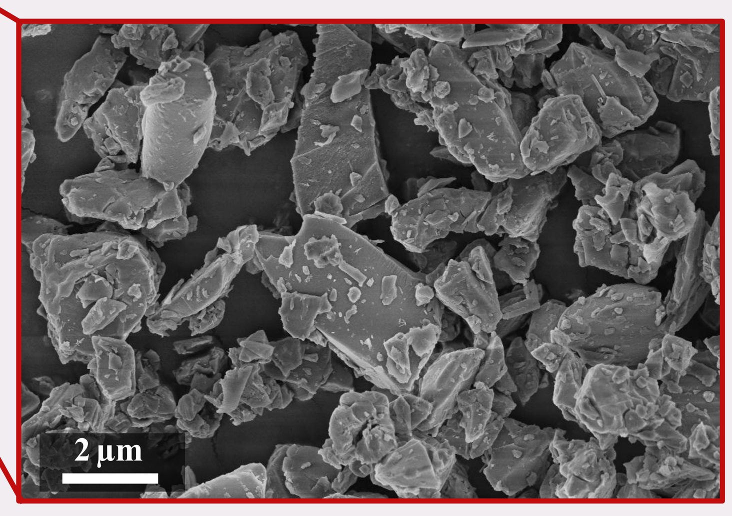


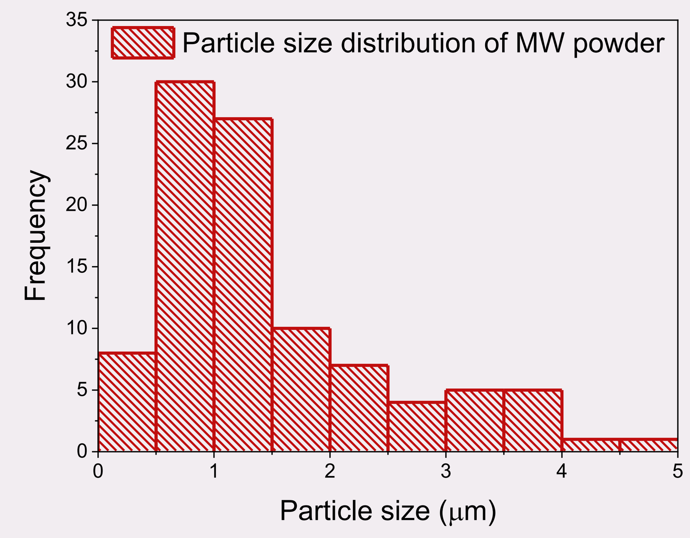
POWDER CHARACTERIZATION



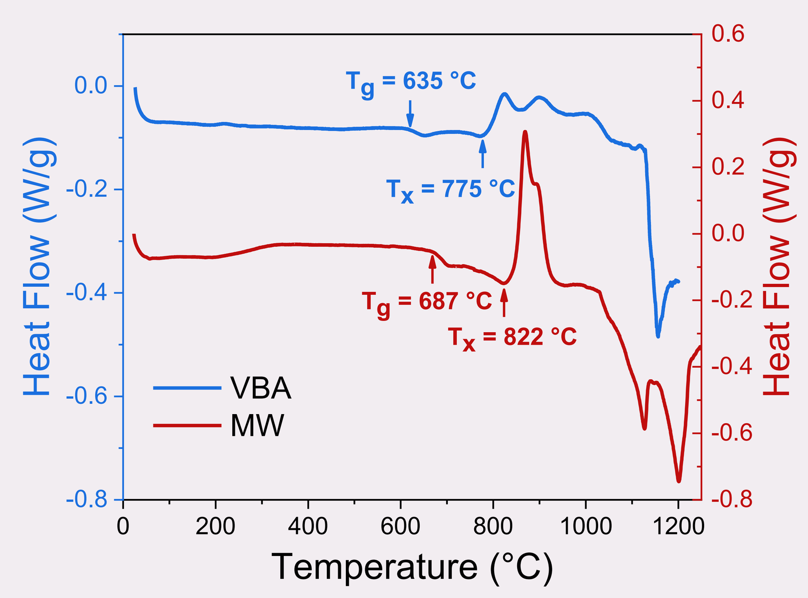


Vitrified bottom ashes (VBA) and mineral wool (MW) were **milled** for 60 s and **sieved** for 60 s under **25 µm**, to obtain **fine powders** that will not interfere with the **3D printing process**.





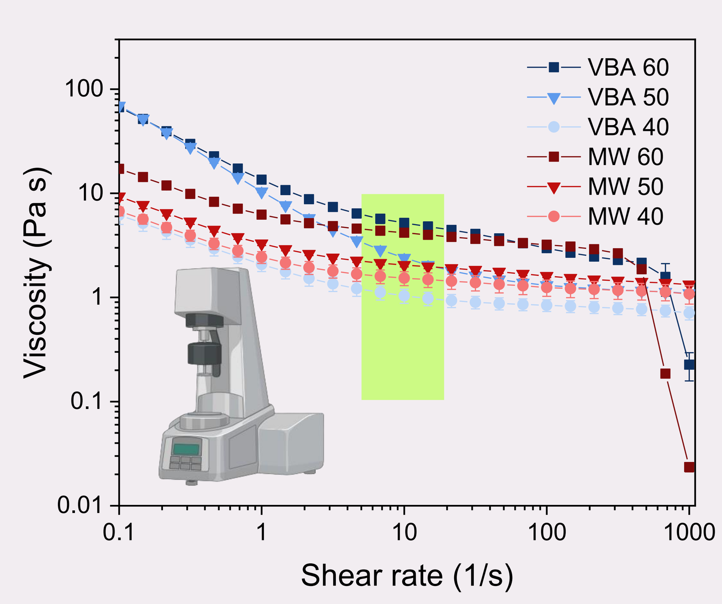
As shown from the particle size distribution for both materials all the sieved particles are under the desired range. Thanks to this it was possible to set the **layer thickness** to **50 µm.**

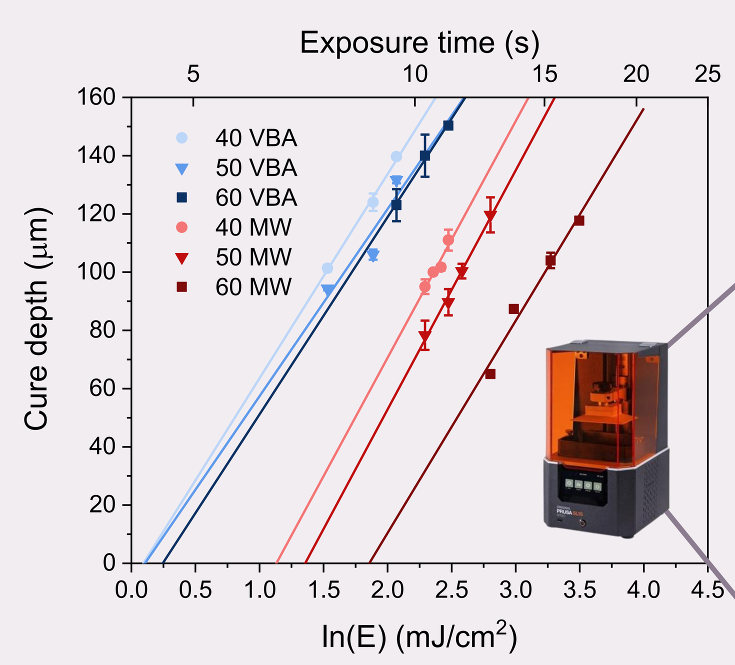


DSC and **HSM** analyses were performed on sieved VBA and MW powders. T_g was determined around **635 °C** for **VBA** and at **687 °C** for **MW**. For both materials crystallization was noted starting at **775 °C** for **VBA** and at **822 °C** for **MW.** According to this, **T** for **sinterization** was established at **950 °C** for both.

These powders were mixed with formulation containing **50 %wt** of **AESO** and **50 %wt** of **IBOA** which has sufficiently low viscosity for our purposes[3]. High contents of **VBA** and **MW powders** were added to the resin formulation: **40, 50 and 60 %wt.**

SLURRY CHARACTERIZATION





All the slurries presented suitable viscosity values for **DLP/SLA** 3D printing (green square), with **shear thinning behaviour**.

Slurry	Time (s) / 50 µm
VBA 40	3.5
VBA 50	3.7
VBA 60	4.1
MW 40	8.7
MW 50	11 .2
MW 60	19.4

TT

RT - 750 °C 0.5 °C/min

Debinding

TGA and **DSC** results on **AESO-IBOA** cured samples indicated complete degradation at **700 °C**.

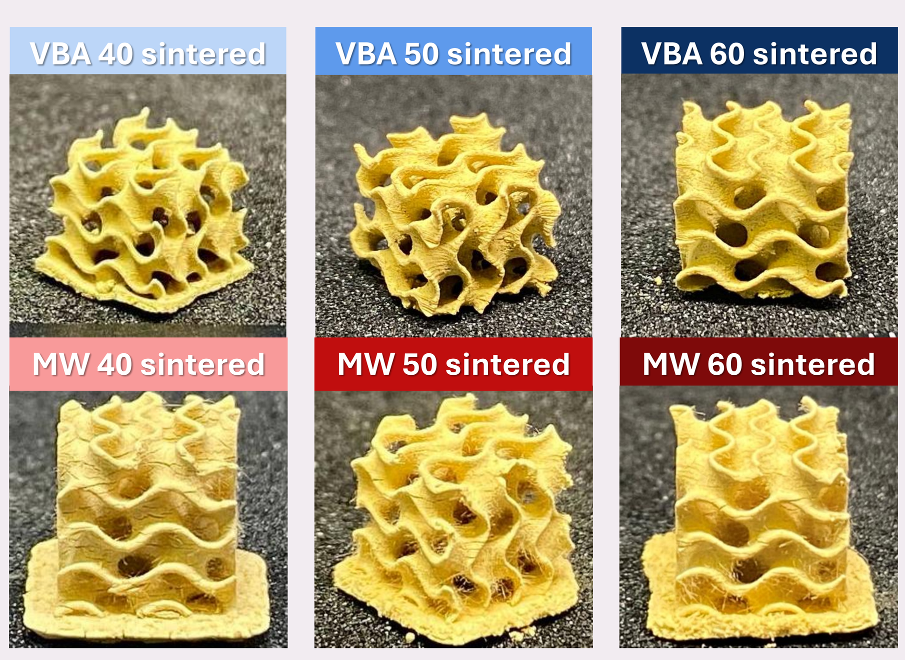
No differences were noted between **argon** and **air** atmospheres, so the treatment was performed in **air**.

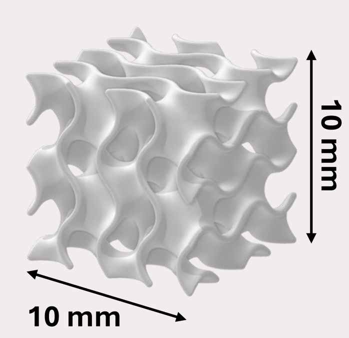
750 - 950 °C 2 °C/min

Sintering

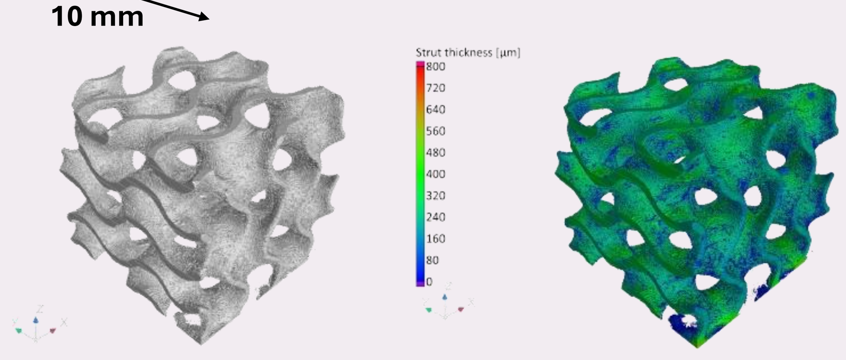
HSM and **DSC** results on **VBA and MW** milled and sieved powders indicated **950 °C** as temperature for **sintering** process.

The **sintering** process was also performed **in air, 1h dwelling.**





Computer tomography scan showed **homogeneous structure** thickness throughout the entire gyroid.



CONCLUSIONS

This study developed **biobased, photocurable slurries** using **epoxidized soybean oil** and **isobornyl acrylate**, incorporating up to **60 wt%** of waste-derived glass powders. **Mineral wool** and **vitrified bottom ash** were processed into fine powders **(<25 µm)**, thermally characterized, and used in **vat photopolymerization**. The **printed porous structures** showed good rheological behaviour, high photo-reactivity, and low surface defects after thermal treatment, demonstrating their potential for sustainable applications such as filtration systems and thermal insulation.

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[1] M.I. Hussain, M. Xia, X.N. Ren, C. Ge, M. Jamil, M.K. Gupta, Digital light processing 3D printing of ceramic materials: a review on basic concept, challenges, and applications, International Journal of Advanced Manufacturing Technology 130 (2024) 2241–2267.
[2] P. Appendino, M. Ferraris, I. Matekovits, M. Salvo, Production of glass-ceramic bodies from the bottom ashes of municipal solid waste incinerators, J Eur Ceram Soc 24 (2004) 803–810.
[3] M. Porcarello, C. Mendes-Felipe, S. Lanceros-Mendez, M. Sangermano, Design of acrylated epoxidized soybean oil biobased photo-curable formulations for 3D printing, Sustainable Materials and Technologies 40 (2024).