cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

Thermal Treatment Effects on the Porosity and Mechanical Performance of 3D-Printed Phosphate-Based Geopolymers Modified with Pluronic F127

Gabriel Tochetto[1,2]; Paolo Colombo[2]; Maria Eliza Nagel-Hassemer[1]; Dachamir Hotza[1]
[1]Federal University of Santa Catarina (UFSC), Brazil; [2]University of Padova (INIPD), Italy

Introduction

- Phosphate geopolymers (PAGP) can be 3D-printed into adsorbent lattices (Franchin et al., 2017; Tochetto et al., 2026a).
- A surfactant template + calcination may open pores, but heat can also weaken the struts (Tochetto et al., 2026b).

Objective

Find the calcination temperature that best balances **porosity** and **strength** in printed PAGP–PLU lattices.

Methodology

1. **Ink:** MK + 10 M H_3PO_4 + PLU + Laponite
2. **DIW:** Ø 840 µm nozzle, 15 × 15 × 8 mm
3. **Cure** 25 °C / 24 h, then **calcine:**

T (°C)	Plateau (h)	Rate (°C min^{-1})
350	6	1
450	4	2
550	2	5

Results and Discussion

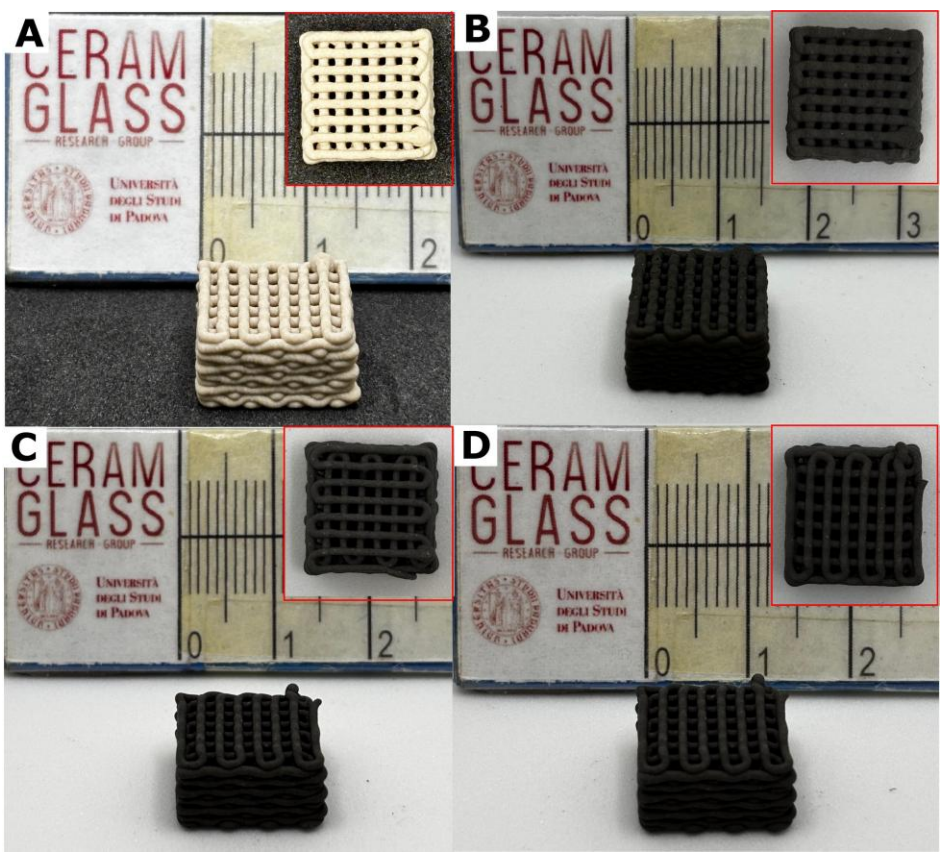


Fig. 1. (A) Uncalcined; (B–D) 350, 450, 550 °C. **Geometry kept** (6–10% shrinkage).

	Unc.	350	450	550
SSA (m^2 g^{-1})	4.9	6.9	6.8	6.5
PD (nm)	10.7	12.8	**17.1**	14.2
PV (10^{-2} cm^3 g^{-1})	1.3	2.2	**2.9**	2.3

Table 1. N_2 sorption (BET/BJH): 450 °C gives the widest mesopores.

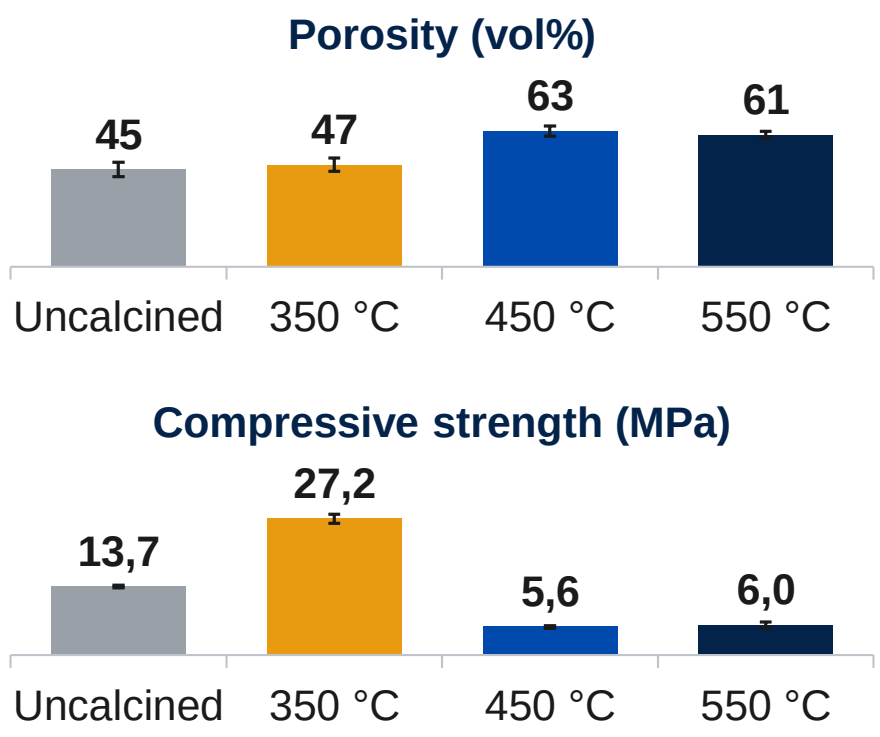


Fig. 2. 350 °C **doubles strength**; at ≥ 450 °C PLU burnout **opens pores** and strength falls.

Conclusions

- Lattices survive calcination up to 550 °C.
- **350 °C** is the choice for **mechanical strength**.
- **450 °C** is the choice for **porosity and adsorption**.

References and Acknowledgements

FRANCHIN, G. et al. Direct ink writing of geopolymeric inks. **J. Eur. Ceram. Soc.**, v. 37, p. 2481–2489, 2017.

TOCHETTO, G. et al. 3D-printed phosphoric acid-activated metakaolin-based geopolymers for acid mine drainage remediation. **J. Water Process Eng.**, v. 87, 110024, 2026a.

TOCHETTO, G. et al. A comprehensive review of phosphate-based acid eopolymers. J. Phys. Chem. Solids, v. 211, 113489, 2026b.

UFSC
UNIVERSITÀ DEGLI STUDI DI PADOVA 1222
CAPES
CNPq