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Rheological Tailoring and Structural Recovery of 3D Printable Phosphoric Acid-Based Geopolymer Inks

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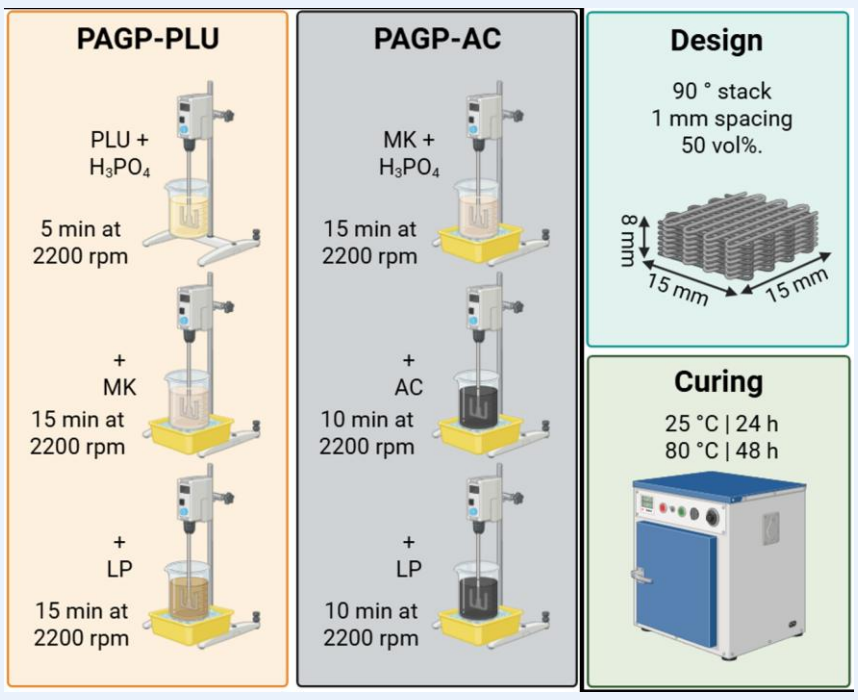
Introduction

- 3D printing by **direct ink writing (DIW)** builds architected adsorbents for water treatment (Tochetto et al., 2026a).
- Acid (phosphate) geopolymers are still rarely printed (Tochetto et al., 2026b).
- A good ink must **flow through the nozzle** and **hold its shape** after deposition (Franchin et al., 2017).

Objective

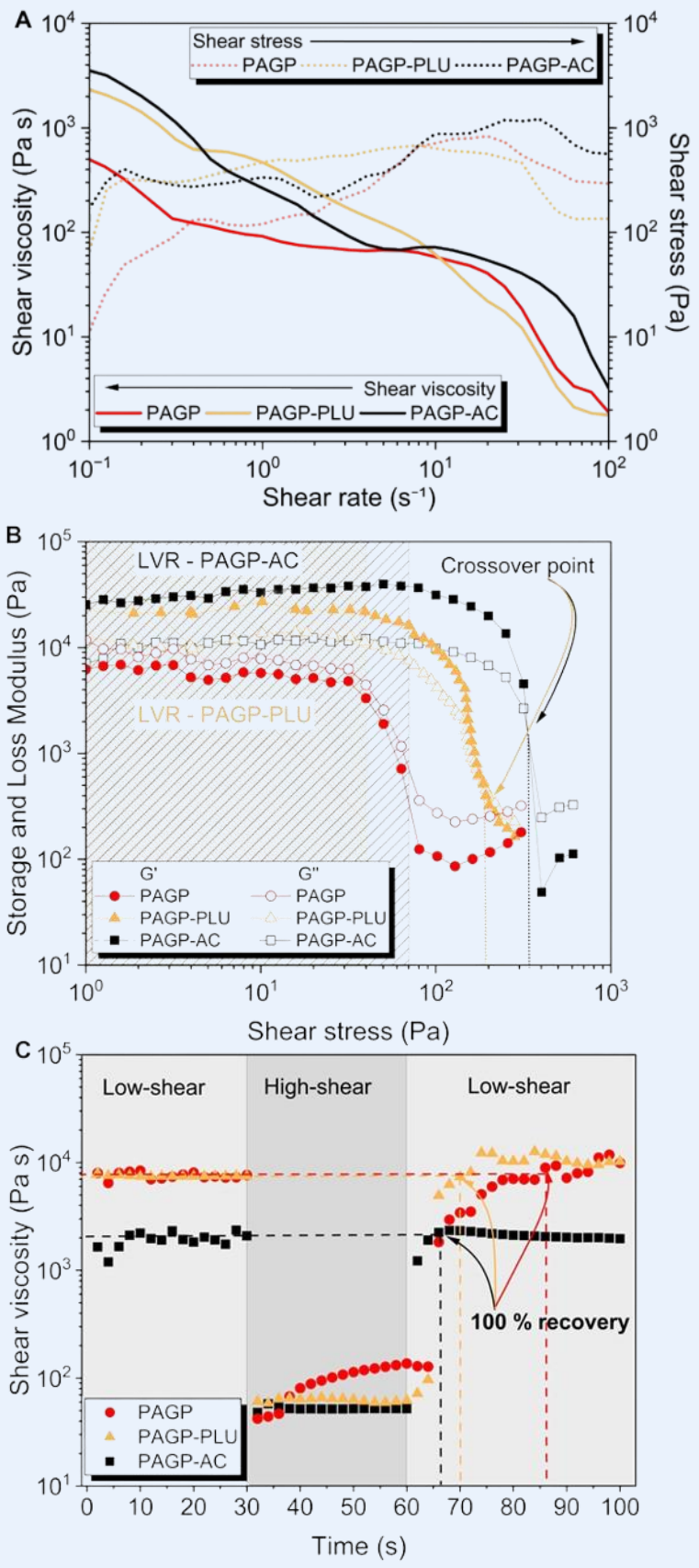
Tailor the rheology of phosphoric acid-based geopolymer (PAGP) inks with **Pluronic F127 (PLU)** or **activated carbon (AC)** for DIW.

Methodology



Rheology: flow curve · amplitude sweep · 3-interval thixotropy test (3ITT)

Results and Discussion



(A) All inks are **shear-thinning**: thick at rest, easy flow in the nozzle.

(B) PLU and AC give a **solid-like ink (G′ > G″)**; PAGP stays liquid-like.

(C) All inks **rebuild viscosity** after high shear; AC is the fastest.

	PAGP	PLU	AC
η at 0.1 s^{-1} (Pa·s)	428	2318	**3167**
LVR limit (Pa)	–	39	**70**
Crossover G′ = G″ (Pa)	none*	193	**320**
Recovery after high shear (s)	26	10	**6**

**G″ > G′ over the whole range. PLU = PAGP-PLU; AC = PAGP-AC.*

Conclusions

- PLU and AC turn a liquid-like ink into a **printable, solid-like ink**.
- AC gives the **strongest particle network**.
- Fast recovery supports **shape retention layer by layer**.

Acknowledgements

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References

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