Reproducible 3D bioprinting and complex mechanical properties of alginate-gelatin hydrogel constructs with decreased concentrations

Anahita Ahmadi Soufivand, Monika Buss, Emine Deniz Bicer, Elmira Zanjani, Silvia Budday[a]

[a] Institute of Continuum Mechanics and Biomechanics, Friedrich Alexander Universität Erlangen-Nürnberg

anahita.a.soufivand@fau.de, silvia.budday@fau.de

MOTIVATION & OBJECTIVES

- **Extrusion-based 3D bioprinting has emerged as a promising technique for fabricating tissue replacements in tissue engineering.**
- **A main challenge is finding reproducible procedures that ensure good printability [1].**
- **The goal is to reach final printed constructs with high shape fidelity, close similarity to the designed model, and controllable mechanical properties.**
- **Creating a less dense microenvironment may reduce the shear stress during the extrusion and enhance biological properties when using cell-laden bioinks.**

METHODS

- **Investigated printability of various concentrations of gelatin-alginate hydrogels.**
- **Used our recently developed procedure for the 2% (w/v) alginate and 5% (w/v) gelatin hydrogel [2].**
  - ✓ **Significantly improved printability and flow stability.**
  - ✓ **Successfully fabricating well-defined constructs.**
- **Decreased bioink concentration by lowering the gelatin concentration to 4%, 3%, and 2% (w/v) and kept the alginate concentration fixed.**

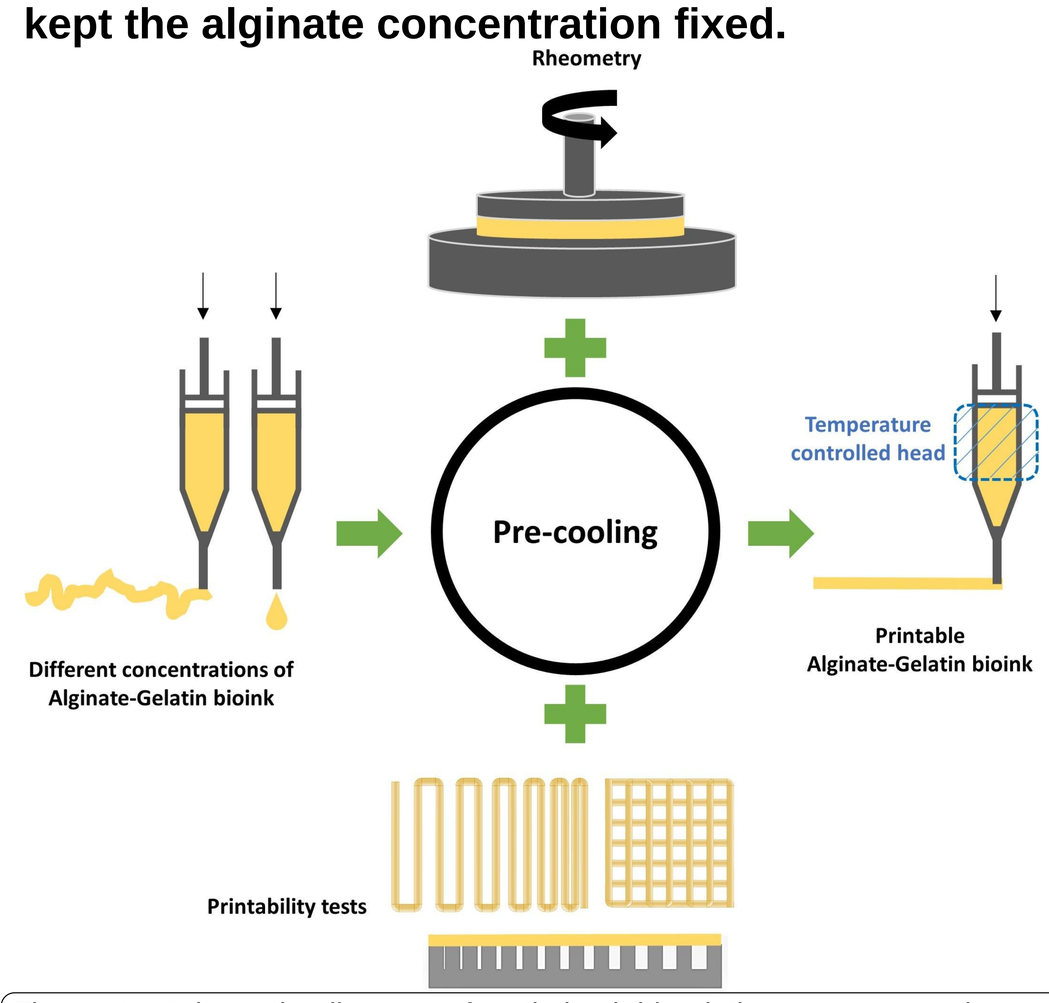


Figure 1. Schematic diagram of optimized bioprinting process: Using a pre-cooling step in combination with rheological measurements and printability tests

RESULTS & DISCUSSION

- **Not all hydrogel concentrations are suitable for printing, and this significantly affects printability.**

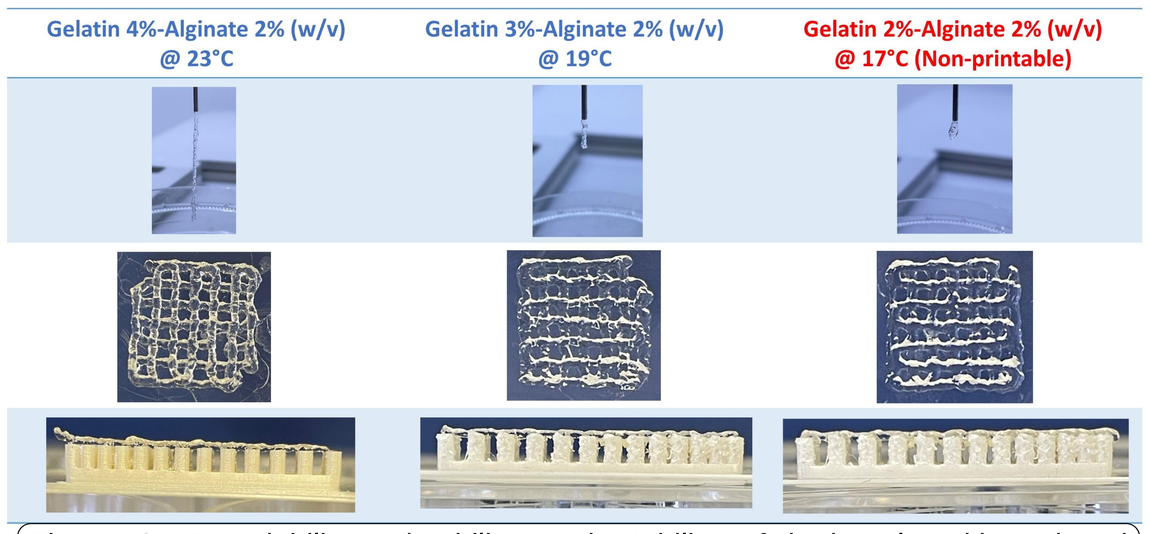


Figure 2. Extrudability, printability, and stability of hydrogels with reduced concentrations at different temperatures

- **The concentration influences the constructs' complex mechanical and rheological properties**

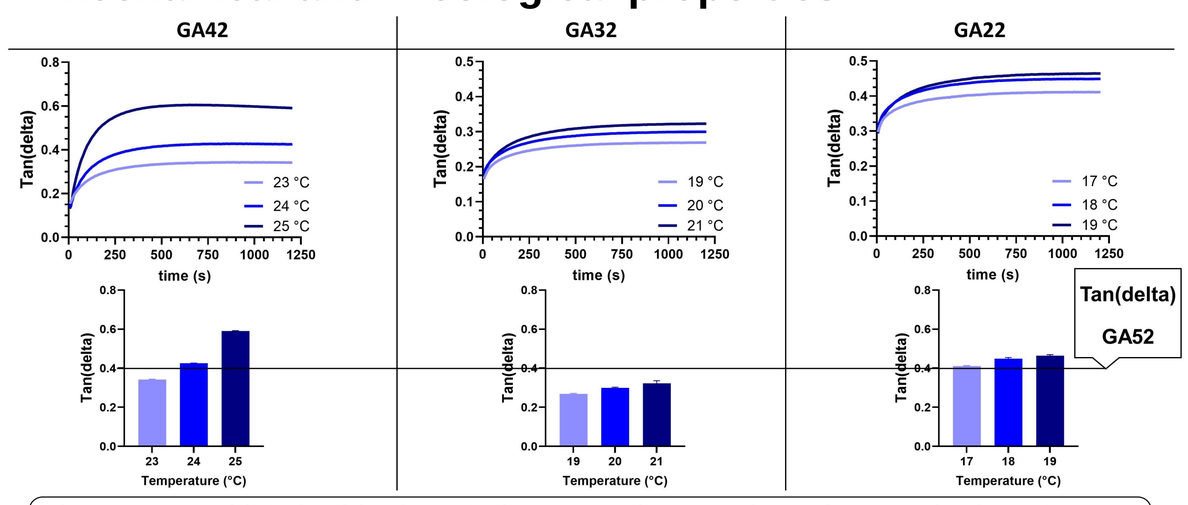


Figure 3. Tan(delta) of hydrogels in comparison to the reference hydrogel GA52 (GAX2 means X% and 2% (w/v) gelatin and alginate, respectively) (n=3)

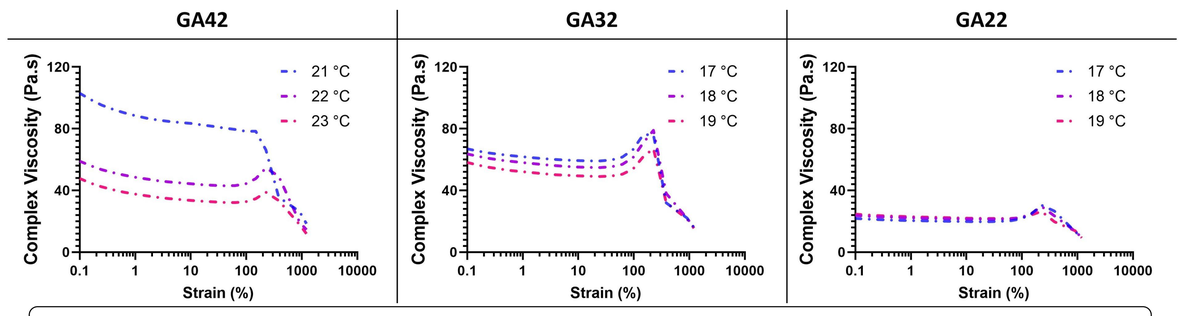


Figure 4. Complex viscosity of hydrogels at different temperatures (n=3)

CONCLUSION

- **Producing replacements with tunable mechanical and biological properties, especially in soft tissue engineering, is possible through this study.**

REFERENCES

[1] A. A. Soufivand; S. J. Lee; T. Jüngst; S. Budday; Progress in Biomedical Engineering, 2025.
[2] A.A. Soufivand, J. Faber, J. Hinrichsen, S. Budday; Scientific Reports, 2023.