Collagen-based inks reinforced with hydroxyapatite nanoparticles for 3D printing: a rheological study comparing bovine and fish sources

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Horizon 2020
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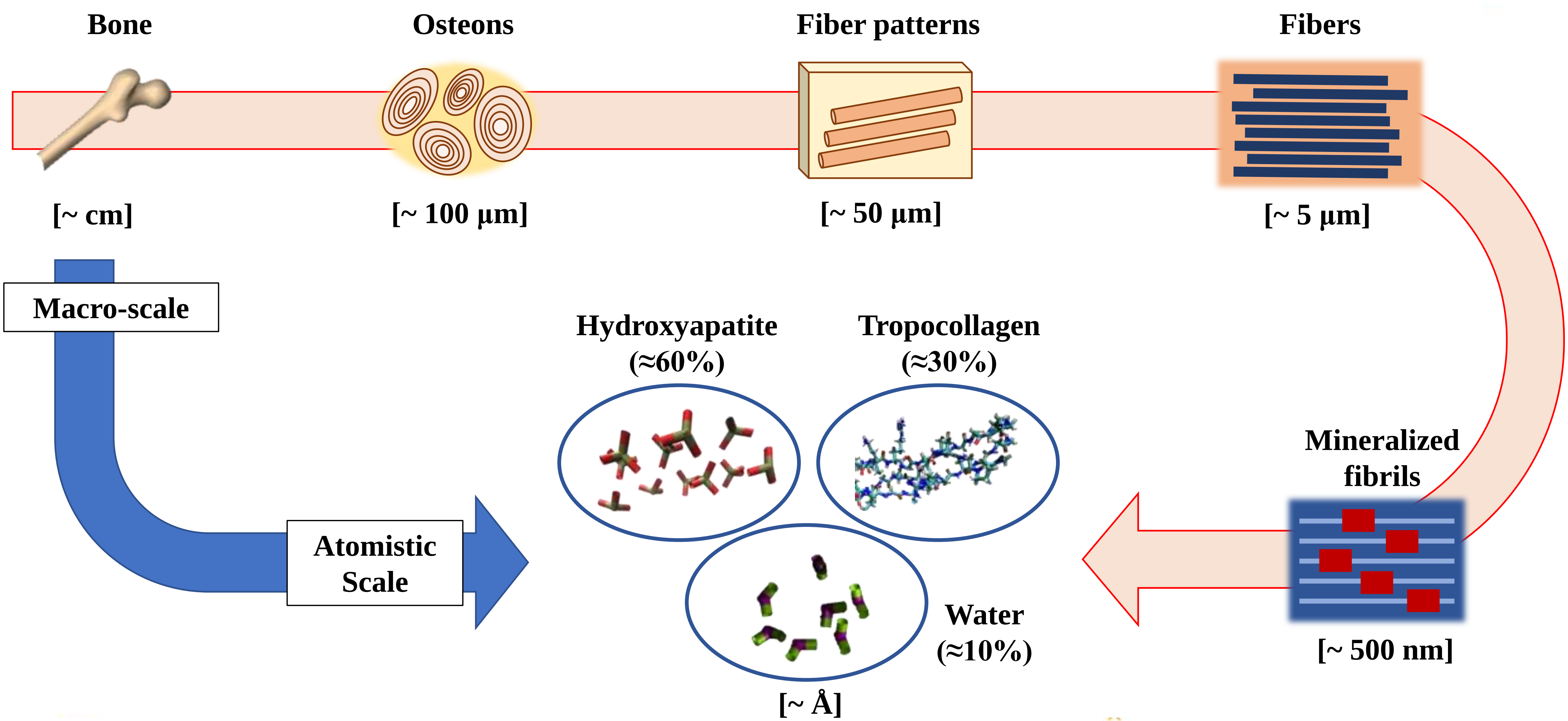
BBI JU

Bio-based Industries Consortium

Introduction: why collagen-based inks?



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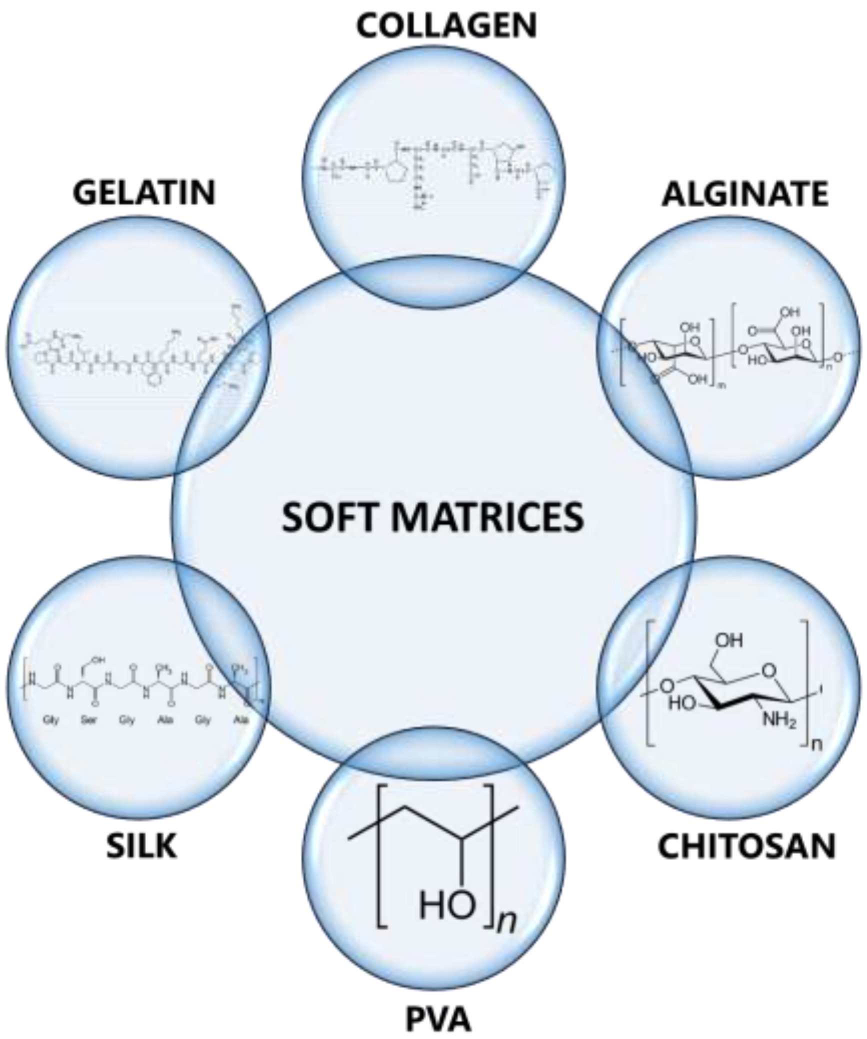

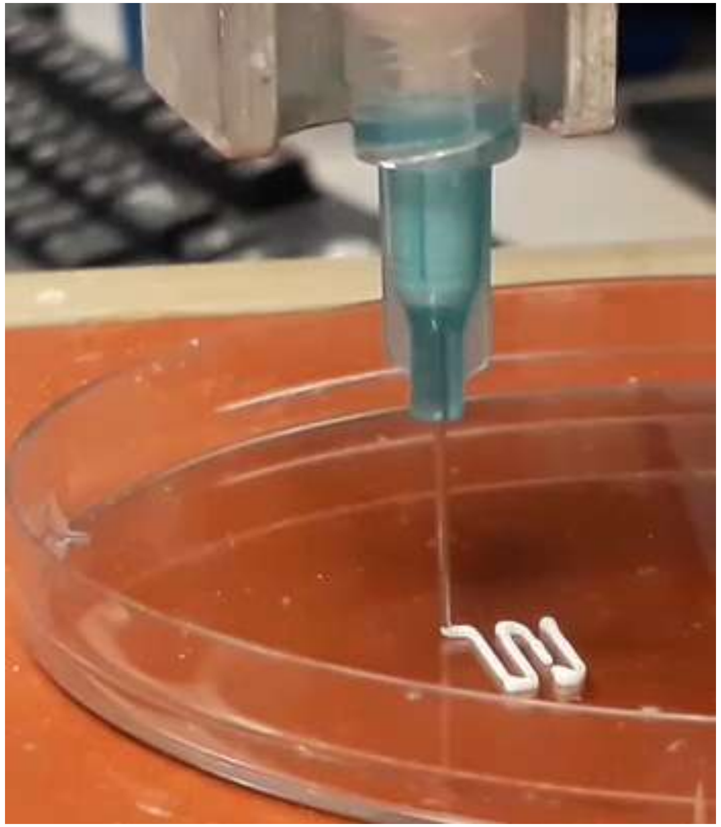

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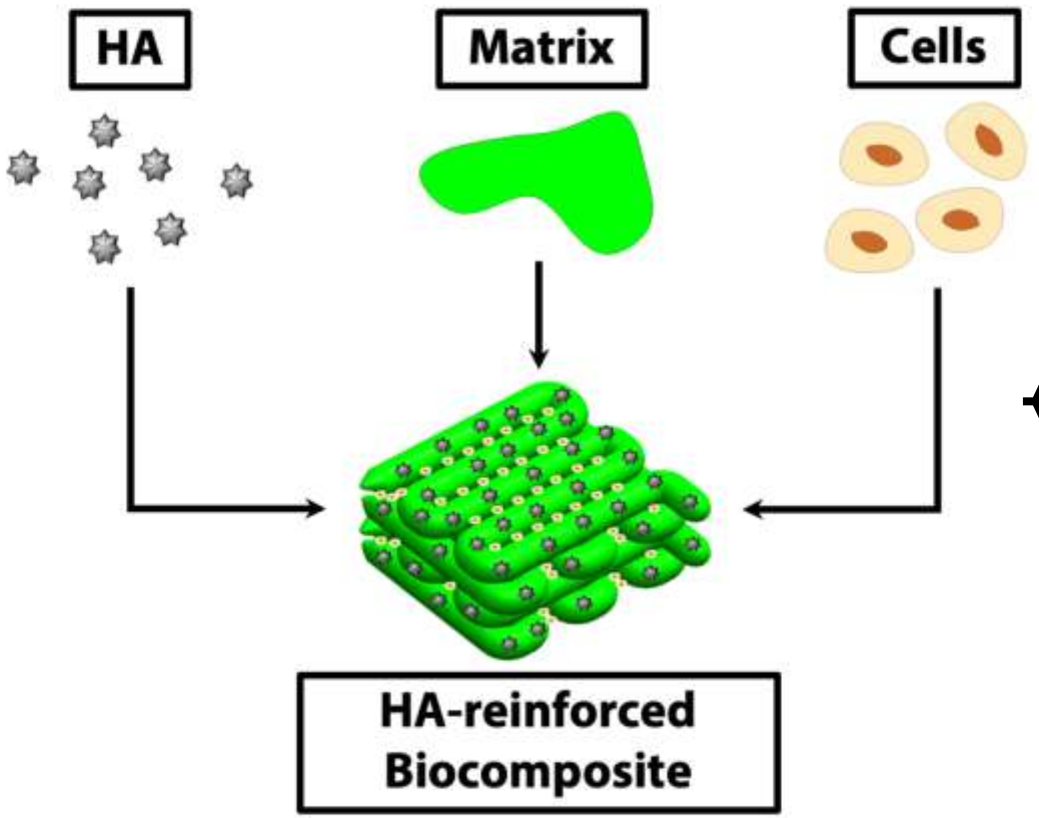

Structural properties

- Balanced resistance/toughness at the macro scale

Biomaterial ink properties

- Improved rheology
- Stabilization after the printing process

Biological properties

- *In vitro*
  - Cell adhesion
  - Osteogenesis (ECM, phenotype)
- *In vivo*
  - Osteoconductivity
  - Fast absorption

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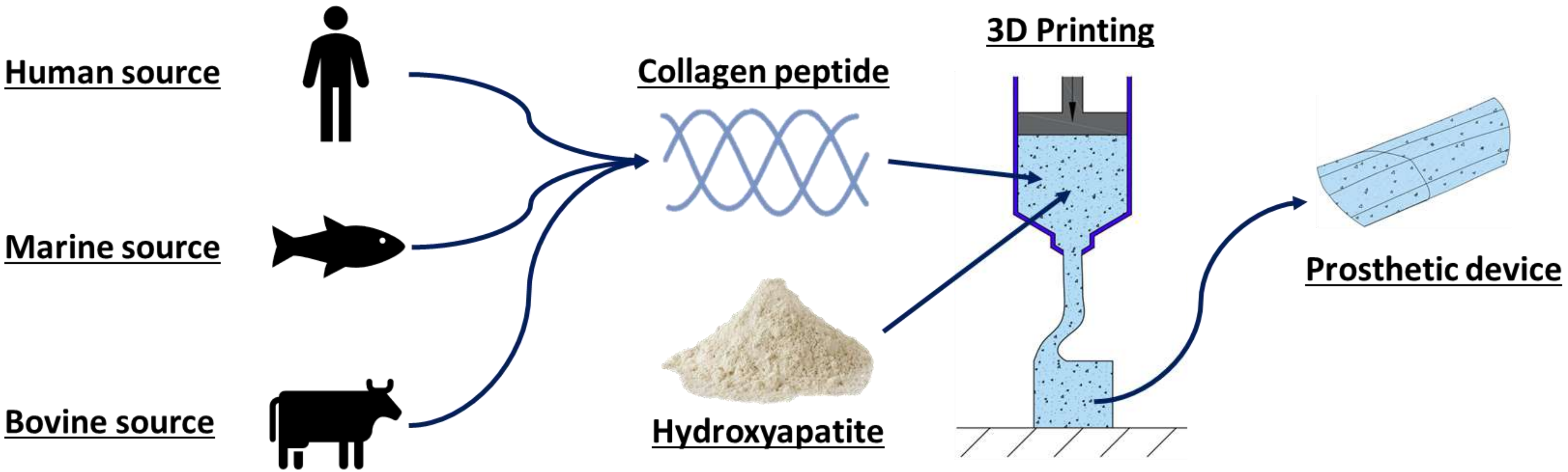


Objective

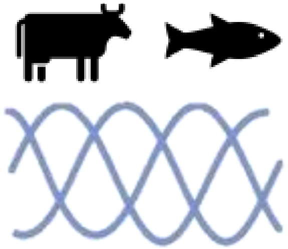
Correlation between rheology and printability of **animal-based collagens** for bone tissue replacements

Materials and methods

Materials

Lapi Gelatine
The Italian Art Of Making Gelatine

SIGMA-ALDRICH



Collagen peptide

$M_w \approx 2$ kDa

Hydroxyapatite

D < 1 µm

Preparation

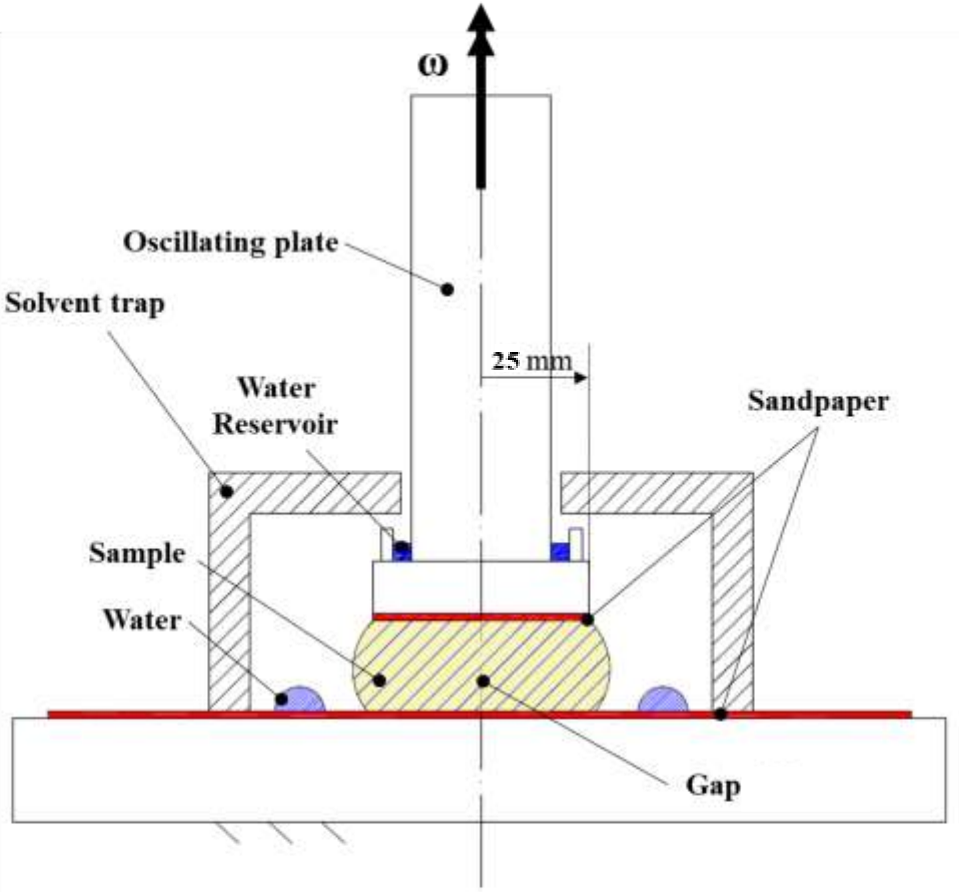
ω = 50 rpm

Acetic Acid

HA-COL-AA ratio of 1.7:1:1

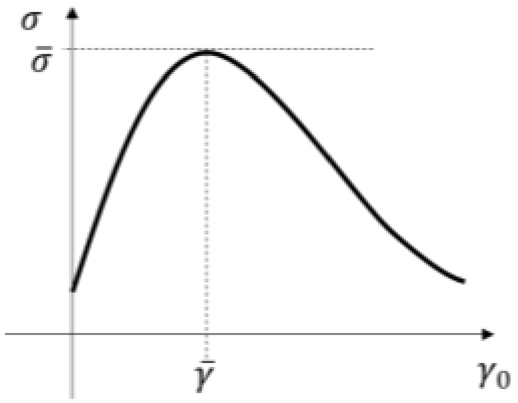
Materials and methods

Rheometer with a plate-plate configuration

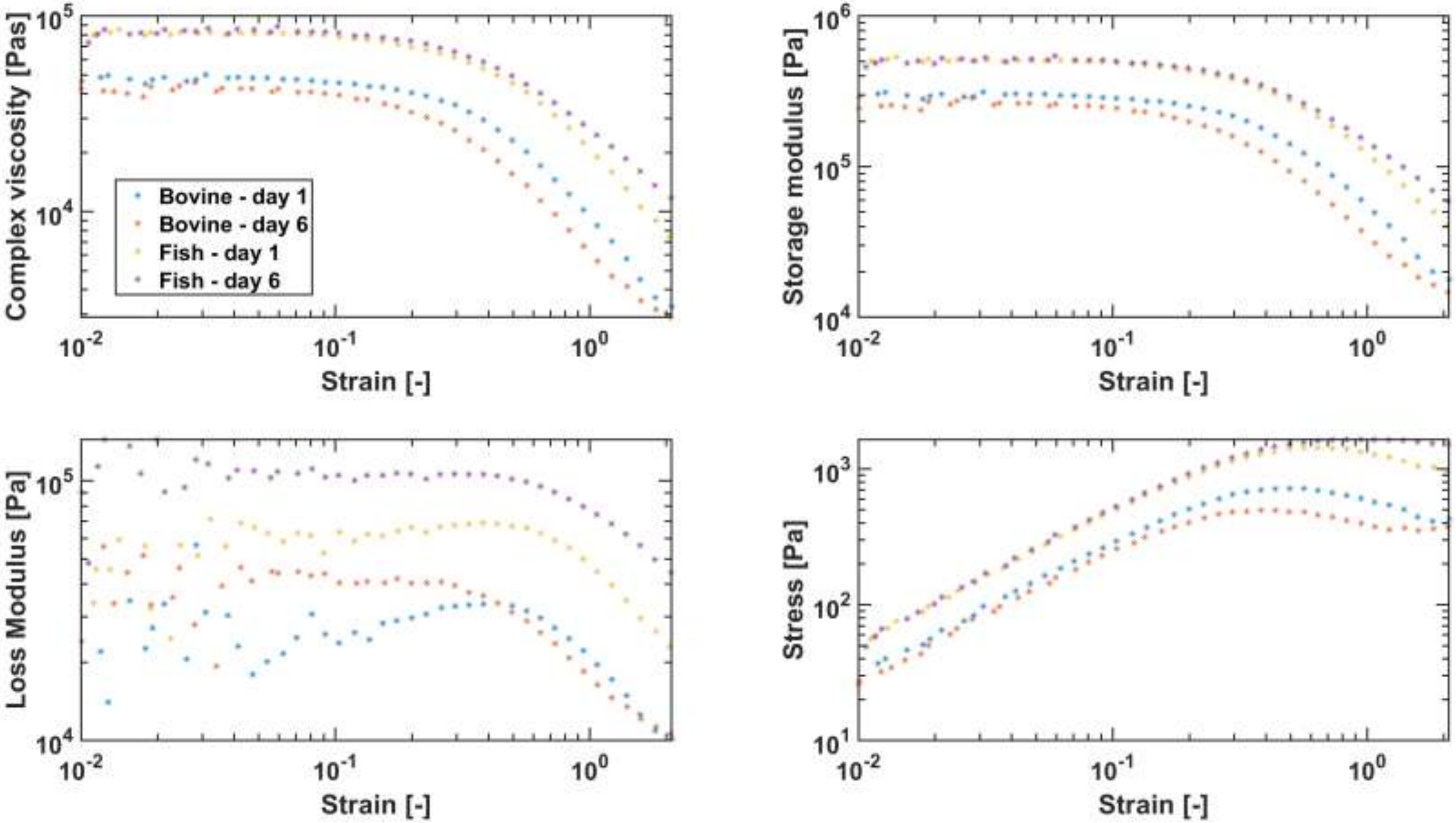


Expected outcomes

- G' -> elastic modulus
- G'_0 -> elastic modulus with no strain
- G" -> viscous modulus
- tan δ = G"/G'
- Yield stress $\bar{\sigma}$
- Yield strain $\bar{\gamma}$



Amplitude sweep



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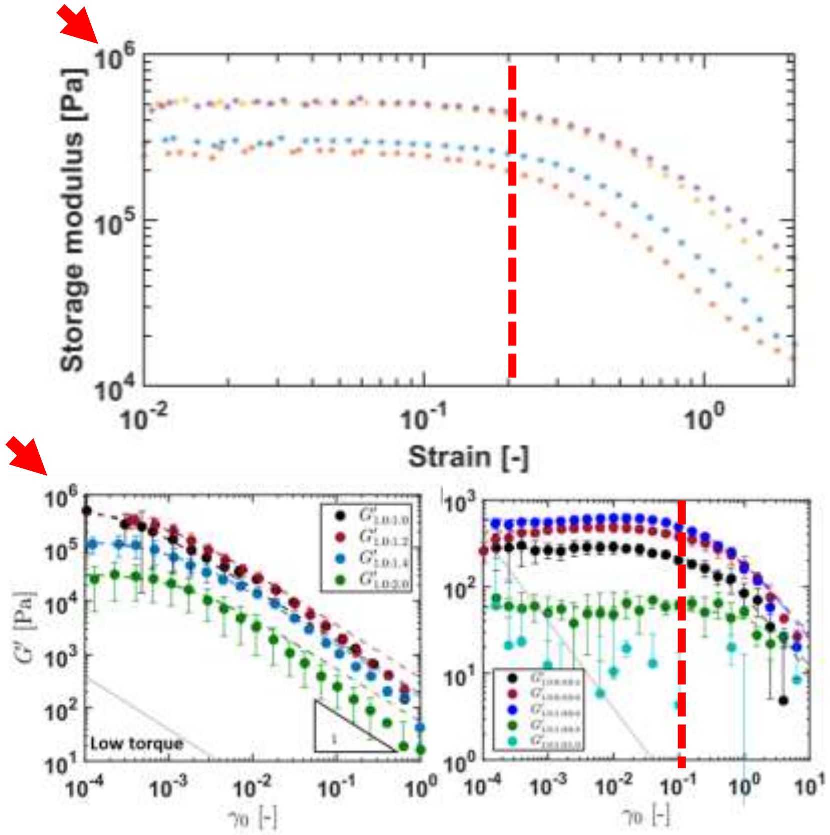
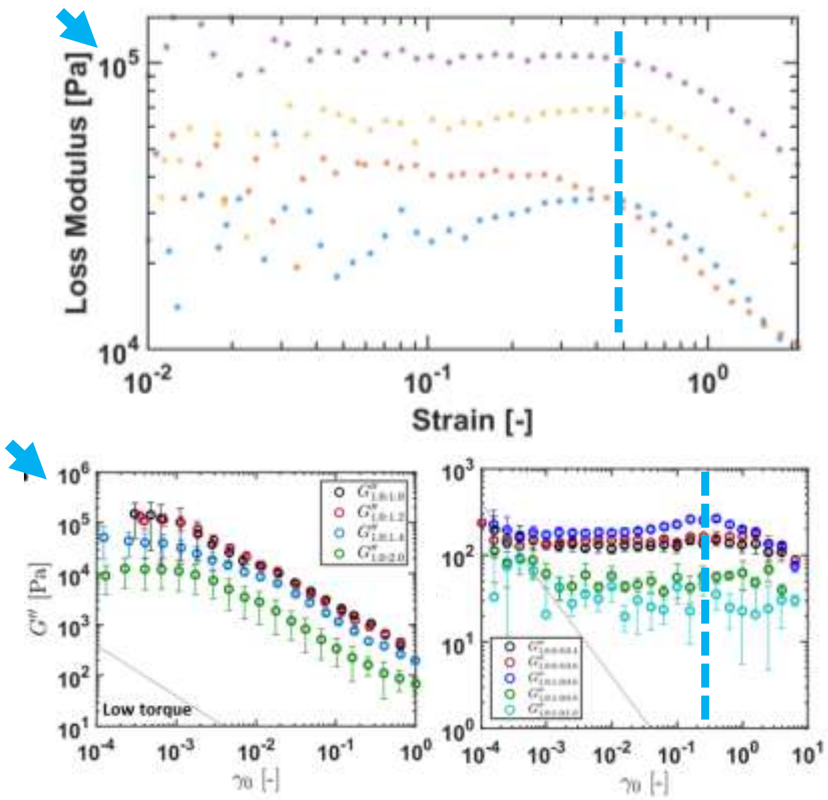


HA/Water HA/Water/Silk



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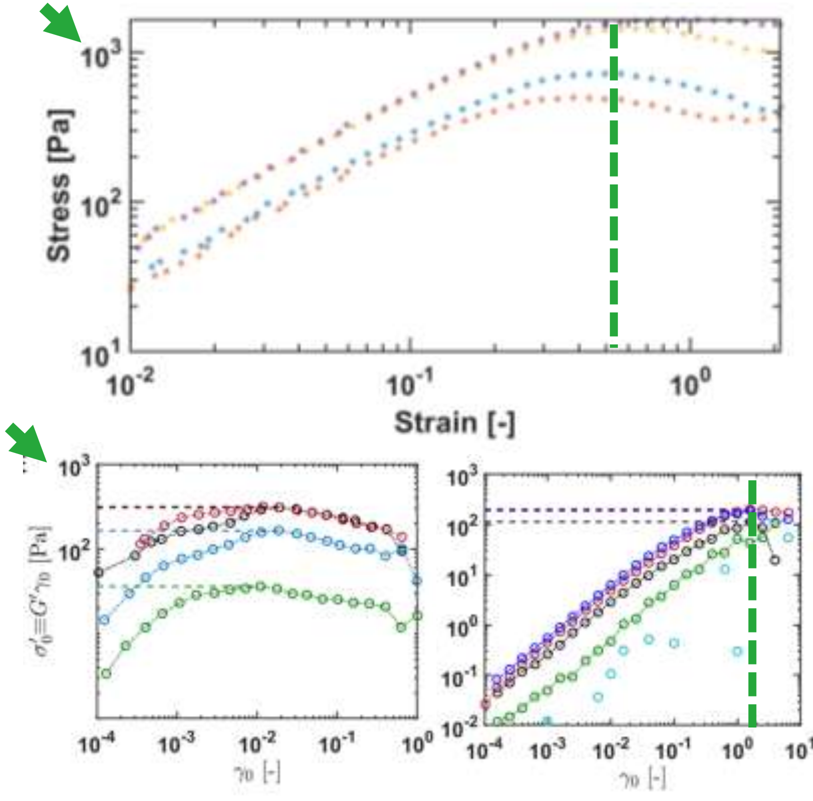
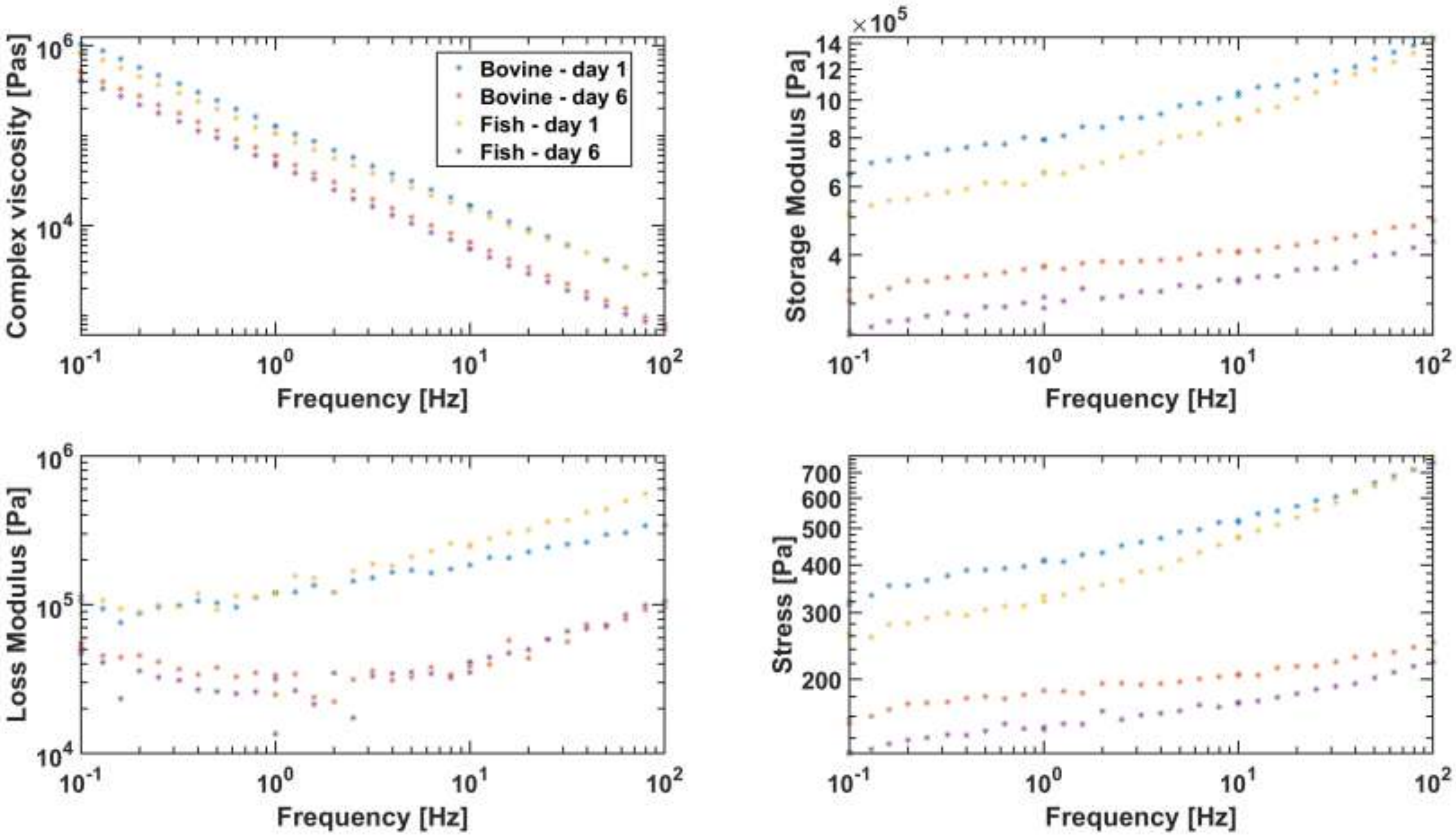
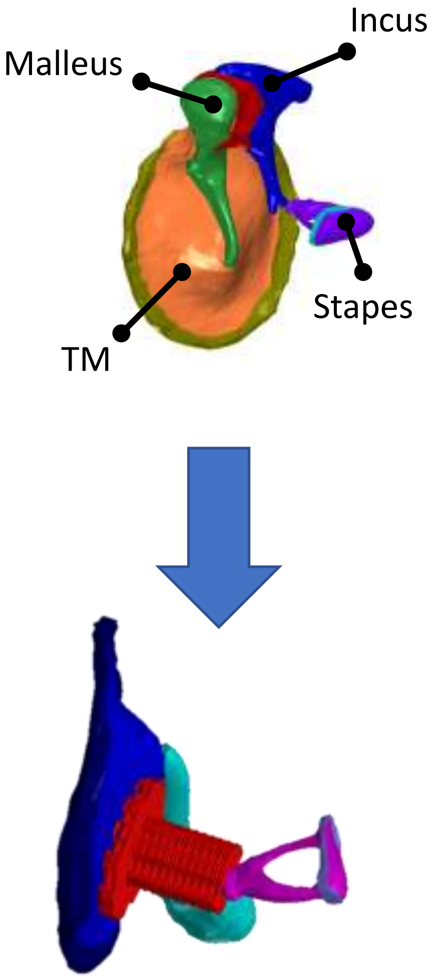


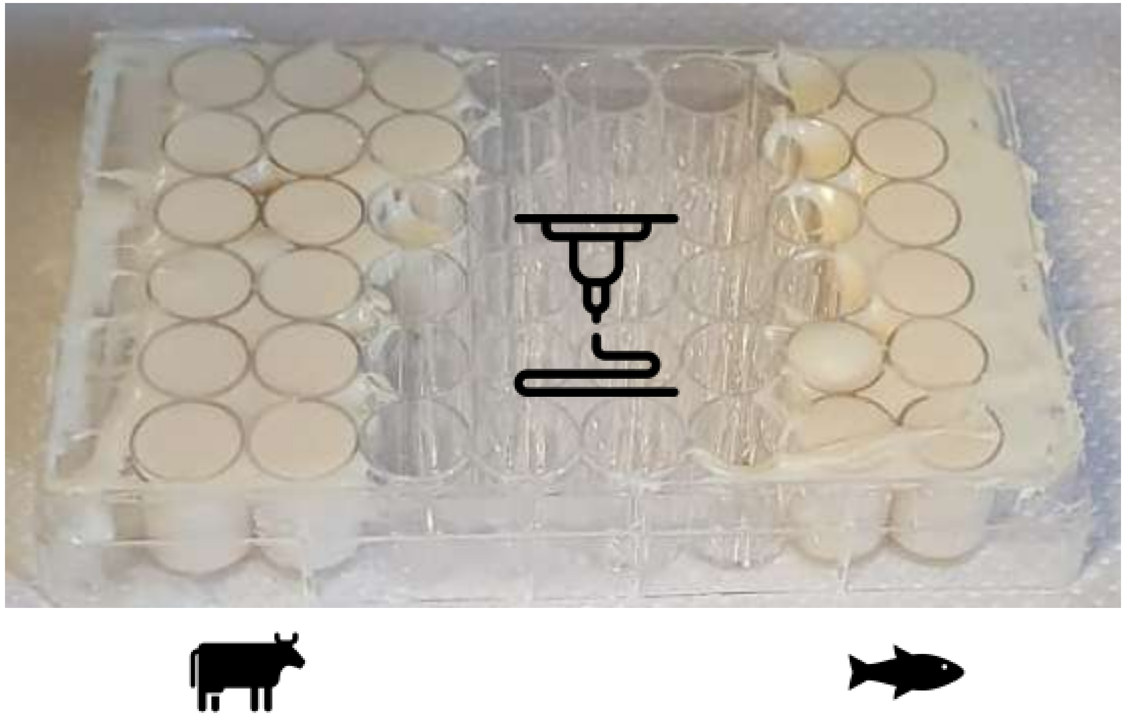
HA/Water HA/Water/Silk

Frequency sweep





Deposition tests



Now under hood for a complete solidification before the mechanical tests.

Next steps

- **Mechanical characterization** of the samples and **assessment of the main mechanical properties** (i.e., stiffness, compressive strength, toughness)
- **Fabrication of simple geometries and assessment of the printing quality** using specific comparative benchmarks (e.g., surface flatness)
- **Correlation between mechanical properties and printability**

Final results expected by the end of July 2022

Thank you for your time!

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