PhD Open Days

Innovating 3D(Cryo)Bioprinting: Designing a Smart Device for Real-Time Controlled Cryopreservation and Tissue Structuring

Doctoral Programme in Mechanical Engineering

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Motivation

Critical Needs in Tissue Engineering and Cellular Agriculture:

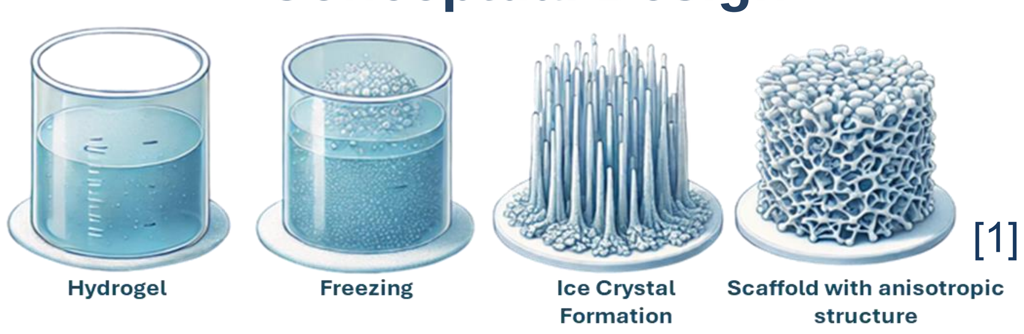
- Precision and structural integrity
- Long-term preservation without loss of cellular functionality
- Real-time monitoring and correction capabilities
- Lack of nutrients and oxygen diffusion
- Limitations when building anisotropic tissues
- Organoleptic properties, namely texture

Proposed Objective

The Need of a Smart, AI-Powered 3d Cryobioprinter:

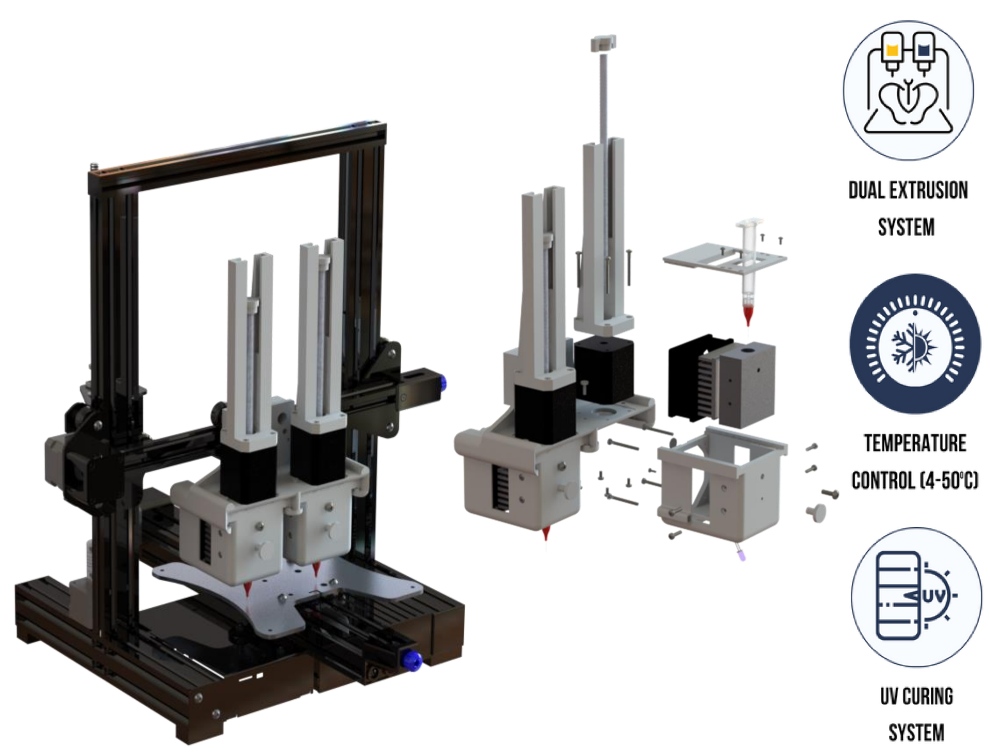
- Structures with automated anisotropic, interconnected, and gradient microchannels formation
- Improved cell alignment which is crucial for the orientation of muscle fibers and other aligned tissues

Conceptual Design

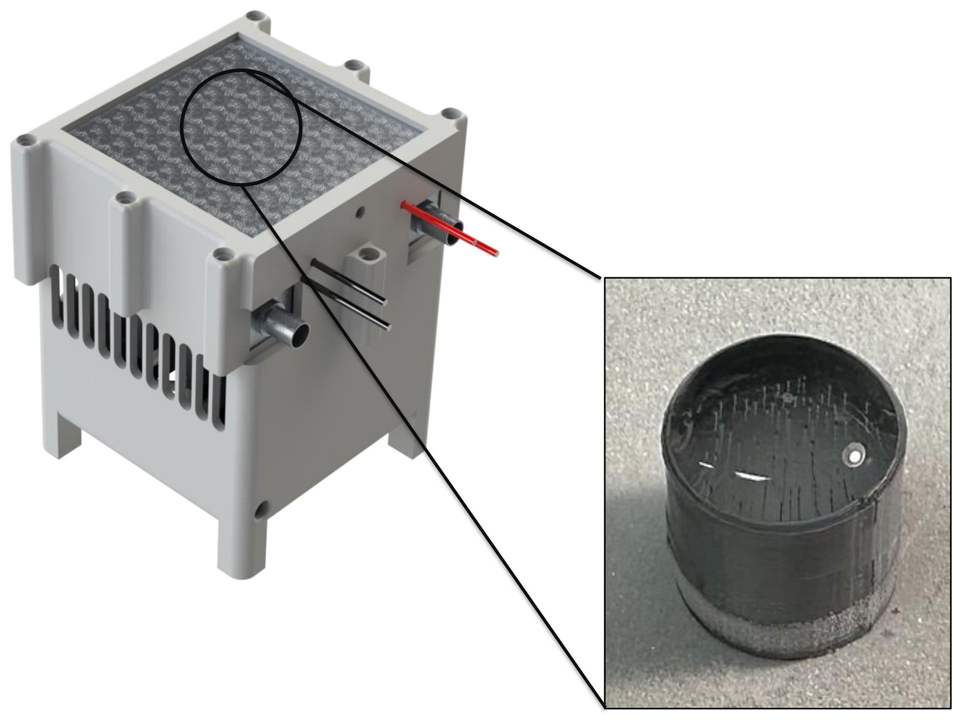


Methodology

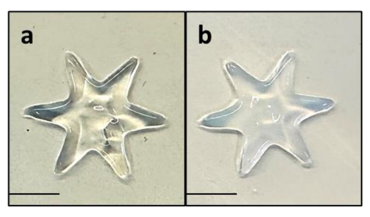
3D Extrusion Bioprinter Compatible with Thermo- and Photo-Curable Hydrogels



Substrate Cooling Mechanism Capable of Reach -30ºC

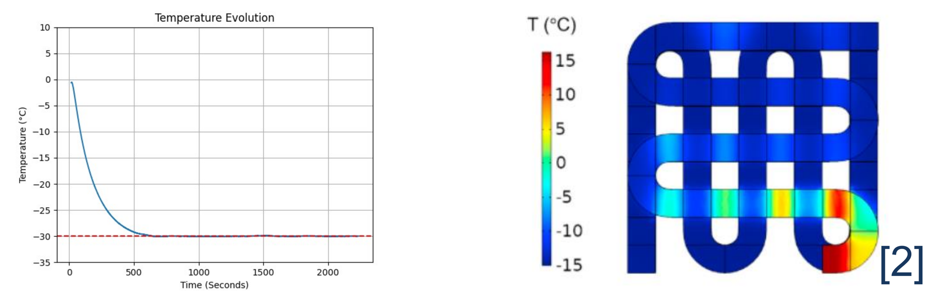


Development of a Photo-Sensitive and Edible Hydrogel



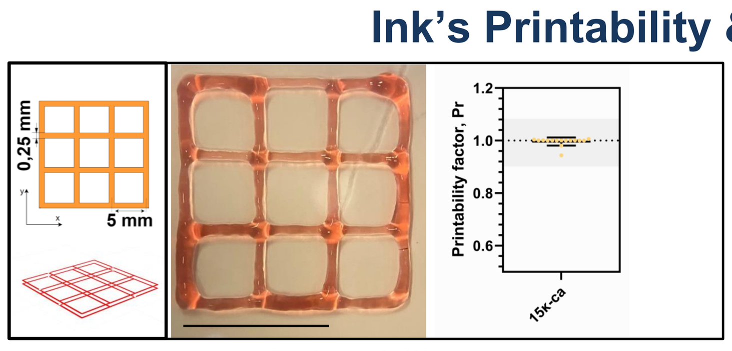
3D printed star using GELMA 5% + PEGDA 20% + CMC 1% + LAP 0.5% (before (a) and after UV exposure (b))

Development of a Real-Time AI-Driven Algorithm with Thermal View Capabilities

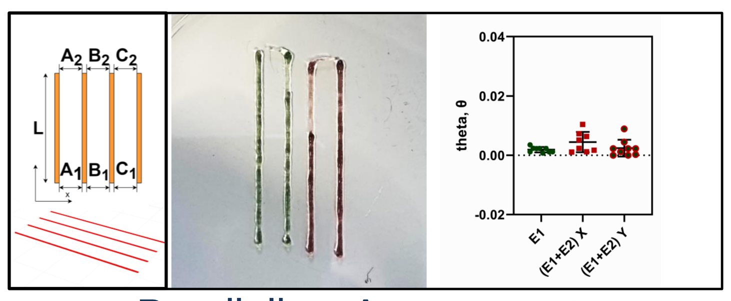


Progress to Date

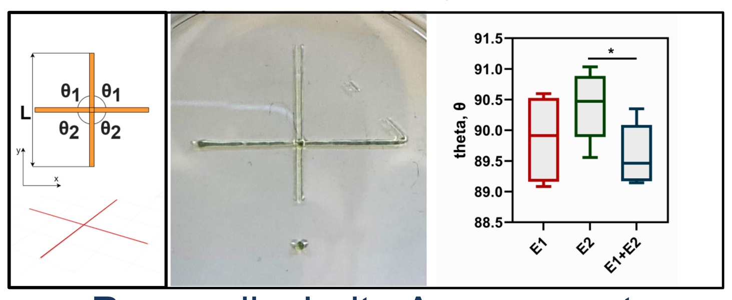
Ink's Printability & Print Resolution



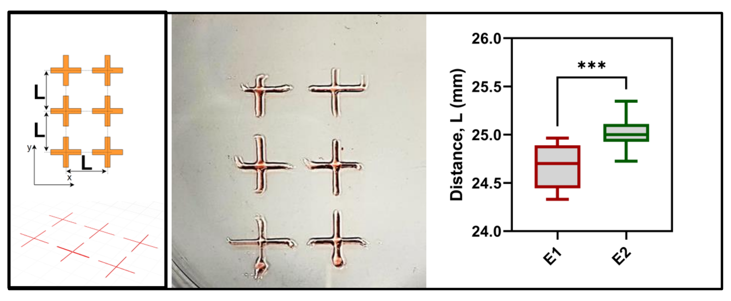
Printability



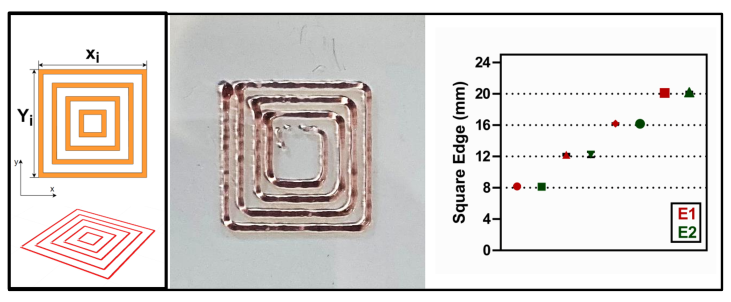
Parallelism Assessment



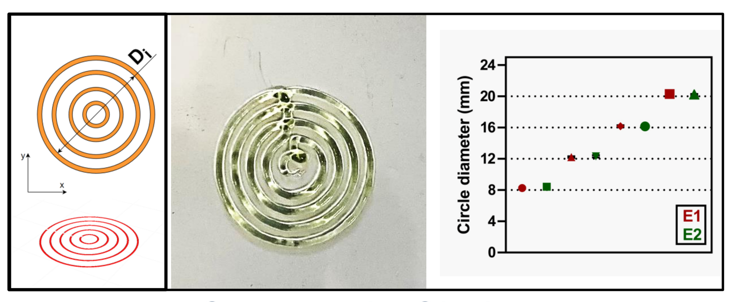
Perpendicularity Assessment



Precision Assessment



Concentric Squares

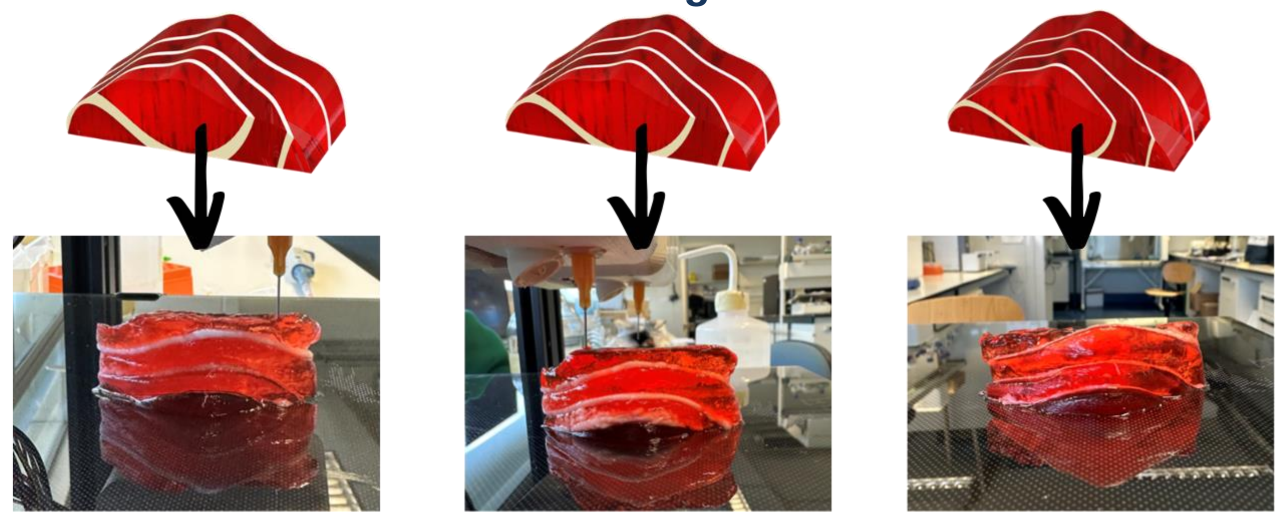


Concentric Circles

Sashimi-Like Prototypes Made with Different Muscle Bioinks

Complex structure offering different organoleptic properties

Whole Cut Fish Fillet Combining Two Inks at Different Ratios



80%/20% 85%/15% 90%/10%

Acknowledgments: The Good Food Institute (GFI) supported this work with its competitive Grant Program through the "Algae2Fish" project. This work was financed by national funds from FCT—Fundação para a Ciência e Tecnologia, I. P., through funding of CleanFish project (2022.07677), the PhD scholarship (2022.12900.BD, 2023.00599.BD), iBB-Institute for Bioengineering and Biosciences (UIDB/04565/2020 and UIDP/04565/2020), i4HB—Associate Laboratory Institute for Health and Bioeconomy (LA/P/0140/2020), CQE—Centro de Química Estrutural (UIDB/00100/2020) and The authors acknowledge Fundação para a Ciência e a Tecnologia (FCT) for its financial support via the project LAETA Base Funding (DOI: 10.54499/UIDB/50022/2020).". The work developed is on the scope of FEASTS (Project ID 101136749) funded by the European Commission funded in the call HORIZON-CL6-2023-FARM2FORK-01-13. Funding from Doctoral INPhINIT Incoming fellowships 2023 BECA reference LCF/BQ/D123/11990049 is acknowledged.

References:

[1] AI Generated

[2] Z. Luo et al., 'Vertical Extrusion Cryo(bio)printing for Anisotropic Tissue Manufacturing', Advanced Materials, vol. 34, no. 12, p. 2108931, 2022, doi: 10.1002/adma.202108931

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