

Title: Development of a Bioactive HAMA/GelMA Hydrogel for Volumetric Printing of Biomimetic Structures

Volumetric 3D printing is an emerging approach in biofabrication that enables the rapid production of complex three-dimensional structures. Unlike layer-by-layer printing techniques, this method allows an entire volume of photosensitive resin to be polymerized in a matter of seconds. However, its use in tissue engineering remains limited by the small number of compatible bioinks, which must both possess suitable optical properties for printing and maintain a biologically favorable environment for cells.

This project aims to develop and characterize a new bioactive hydrogel formulation based on a GelMA (gelatin methacryloyl) and HAMA (hyaluronic acid methacrylate) mixture for volumetric printing. The goal is to design a resin that enables both efficient polymerization during printing and a supportive environment for cell viability. The potential addition of PEGDA may also be explored to fine-tune mechanical properties and crosslinking kinetics.

The first work axis will focus on material formulation and characterization. HAMA will be synthesized, and different molecular weights may be investigated. Methacrylation will be analyzed (by NMR if possible, or by FTIR for qualitative estimation). These polymers will then be incorporated into GelMA/HAMA hydrogel formulations at various ratios, optionally complemented with polyethylene glycol diacrylate (PEGDA) to adjust mechanical properties and crosslinking. Simple UV photopolymerization tests will be conducted to assess the reactivity of the formulations, followed by mechanical characterization of the resulting hydrogels (Young's modulus and storage modulus).

The second project axis will address the compatibility of the formulations with volumetric printing. The optical properties of the resin (refractive index, absorbance) will be measured to verify their suitability for the printing technique. Volumetric printing polymerization tests and light-dose adjustments will be carried out to determine the conditions required to produce stable and well-defined hydrogel structures, with the ultimate goal of creating more complex structures, such as those containing microchannels.

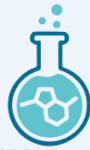
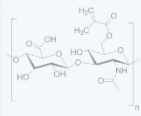
Finally, in parallel, a third axis will focus on evaluating the biological activity of the hydrogels. Cell viability assays (MTT or Alamar Blue) will be performed using fibroblasts or endothelial cells. Cell morphology will also be studied using fluorescent labeling to assess the interactions between cells and the different formulations (HAMA molecular weight and ratios). These tests can be conducted on hydrogel discs.

This project will thus explore the potential of HAMA/GelMA hydrogels as bioinks for volumetric printing and provide insights into how formulation affects the mechanical, optical, and biological properties of the material.

Bioactive HAMA/GelMA Hydrogel for Volumetric printing of biomimetic structures

Axis 1 : Formulation and Characterisation

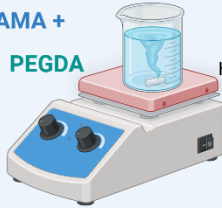
Varying HAMA Mw



Synthesis of HAMA

GelMA +
HAMA +
PEGDA

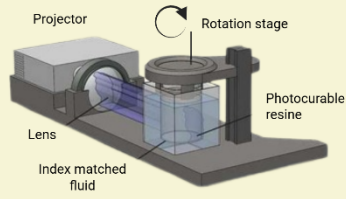
Mixing



Varying
HAMA/GelMA
Ratios +/-
PEGDA

*UV Polymerisation / Mechanical
Testing*

Axis 2 : Volumetric Bioprinting



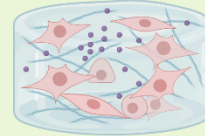
- 1) Refractive Index / Absorbance
- 2) Light Dose Testing



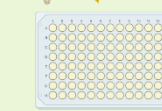
Microvessels structure Printing

Axis 3 : Biological Validation

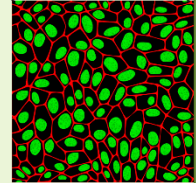
**GelMA / PEGDA
Vs GelMA / HAMA**



MTT, Alamar
Blue



*Cells Viability
Assays*



*Cells
Morphology
Analysis*