Laser-microstructured Cu-doped bioresorbable glasses: tailoring cell response for regenerative medicine

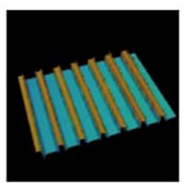
E. Peluso[1], *M. Giannaccari[1], D. M. N. Menon[2], E. Galleano[3], D. Jenner[2], P. Minzioni[3], L. Visai[1,4,5]*

[1]Molecular Medicine Department (DMM), Centre for Health Technologies (CHT), Unità di Ricerca (UdR) INSTM, University of Pavia, 27100 Pavia, Italy
[2]Department of Applied Science and Technology (DISAT) and RU INSTM, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy
[3]Department of Electrical, Computer and Biomedical Engineering, University of Pavia, 27100 Pavia, Italy
[4]UOR6 Nanotechnology Laboratory, Department of Prevention and Rehabilitation in Occupational Medicine and Specialty Medicine, ICS Maugeri IRCCS, 27100 Pavia, Italy
[5]Interuniversity Center for the Promotion of the 3Rs Principles in Teaching and Research (Centro 3R), Operative Unit (OU) of University of Pavia, 27100 Pavia, Italy

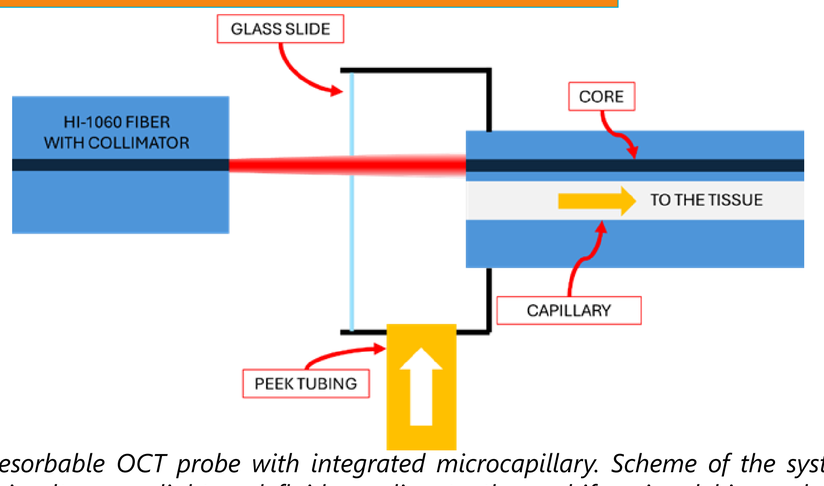
emanuela.peluso01@universitadipavia.it

INTRODUCTION

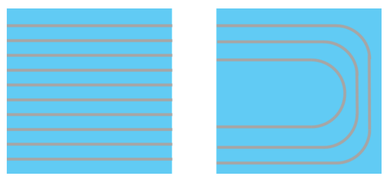
- Bioresorbable photonic components are emerging as promising tools for medical applications, combining sensing and therapeutic functions such as cancer treatment, wound healing, and infection control. However, their clinical translation remains limited.
- In this study, an infrared pulsed laser (ns) was used to microstructure Cu-doped calcium phosphate bioresorbable glass, enabling the investigation of biological responses to surfaces with controlled microstructure dimensions (height: 2-12 µm; width: 20-100 µm).



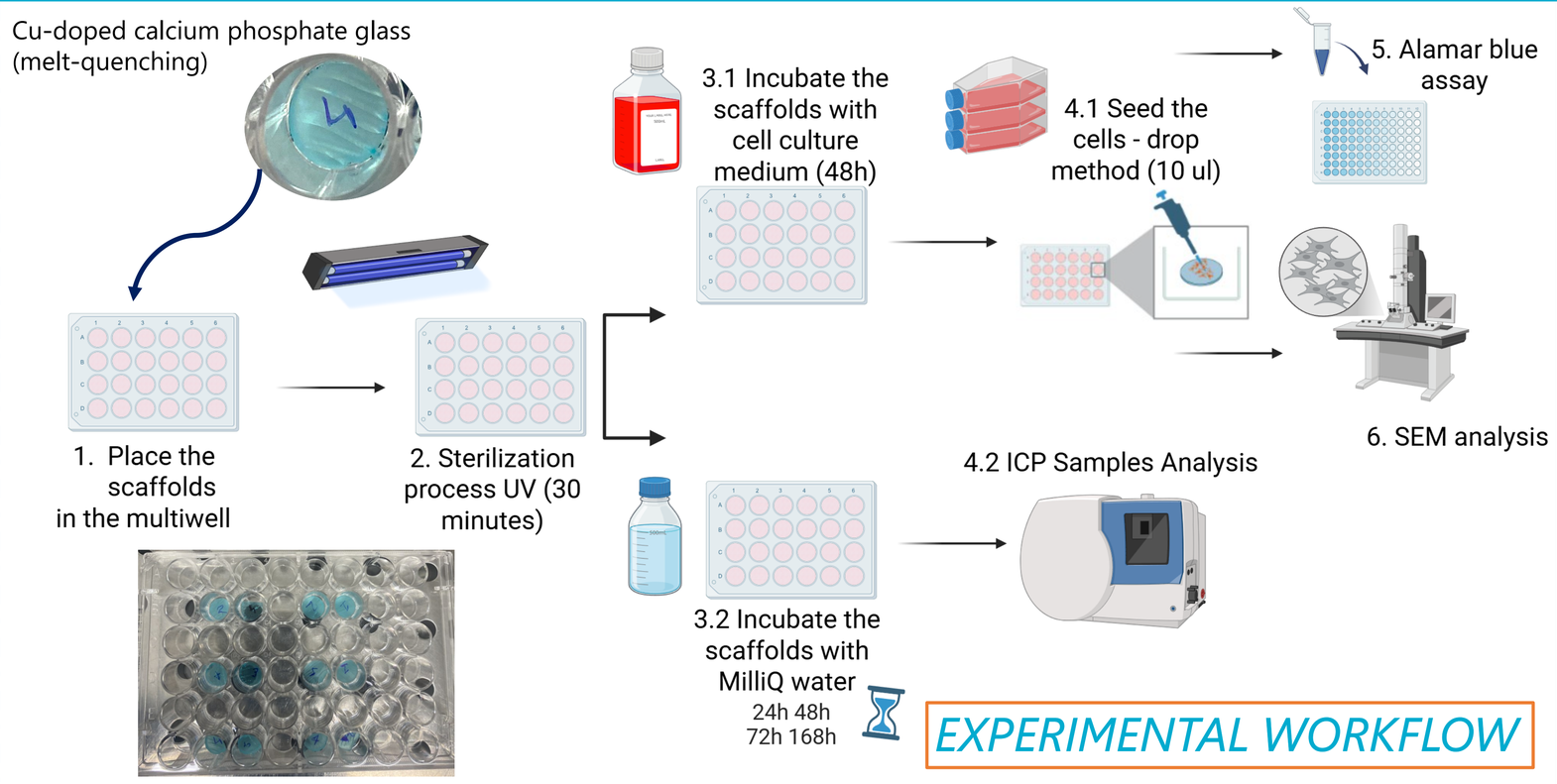
MATERIALS AND METHODS



Bioresorbable OCT probe with integrated microcapillary. Scheme of the system for simultaneous light and fluid coupling to the multifunctional bioresorbable probe.

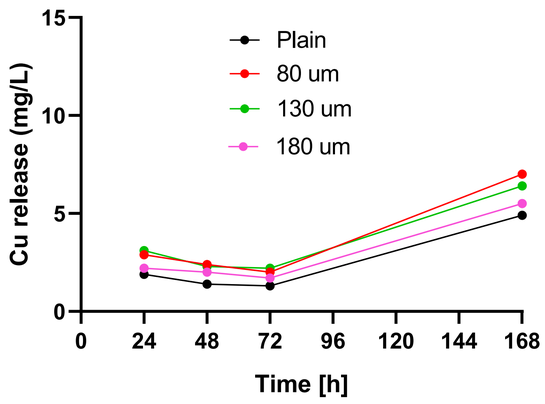


Microstructuring of flat bioresorbable substrates. Scheme of the tested approaches. Left: parallel trenches on the bioresorbable glass substrate. Right: curved trenches.



RESULTS

1. ICP analysis

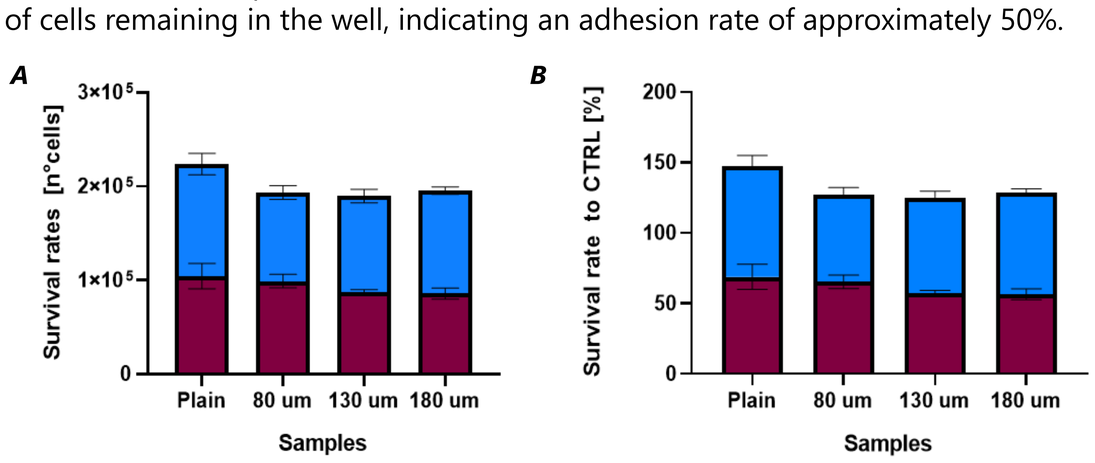


- Copper release was quantified over time.
- The measured concentration was relatively low, corresponding to reduced cytotoxicity.
- pH values remained slightly acidic (around 6) at early timepoints.

Figure 1 - Cu release (mg/L)*. Rate of release of Cu against time (24, 48, 72, and 168 h) upon immersion in ddH2O.*

2. Direct test

A linear relationship was observed between the number of adhered cells and the number of cells remaining in the well, indicating an adhesion rate of approximately 50%.



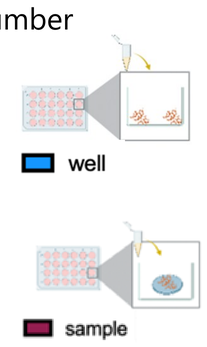


Figure 2 - NIH-3T3 cell viability on bioglasses samples. *Cell viability was evaluated using the Alamar Blue assay on four bioglasses samples: Plain, 80 µm, 130 µm, and 180 µm. Data are presented as survival rate as absolute cell number (**A**), as % survival rate to CTRL (**B**). Results are represented as mean ± standard deviation (SD).*

3. SEM Analysis

- Cells were evenly distributed.
- In samples with larger grooves (e.g., 130 µm), cells were less visible, likely residing within the grooves.
- On plain surfaces, cells appeared round, indicating limited adhesion.

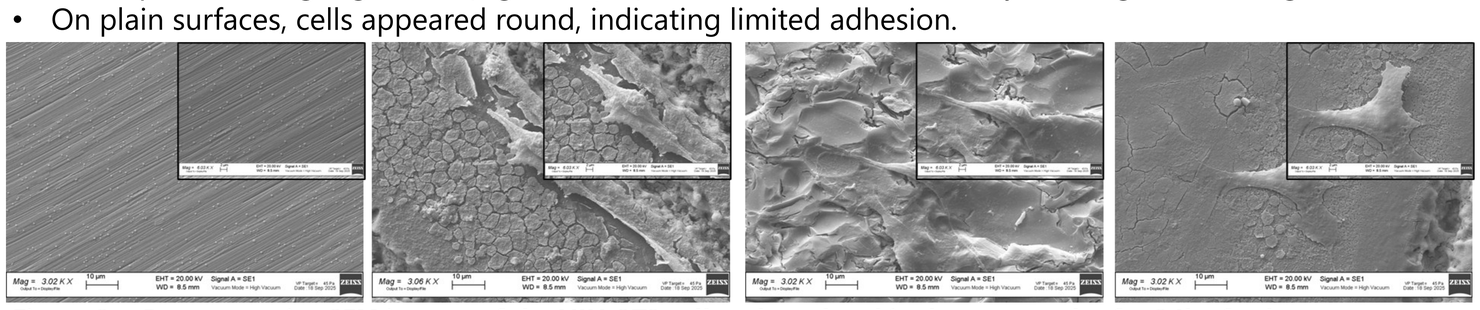


Figure 3 - Representative SEM images of the NIH-3T3 cells cultured on bioglasses samples for 24h of culture.
Images were acquired at 30000× (scale bar 10 µm)), insets 6000× (scale bar 2 µm) magnification.

4. Indirect test

Cell morphology improved with increasing dilution.

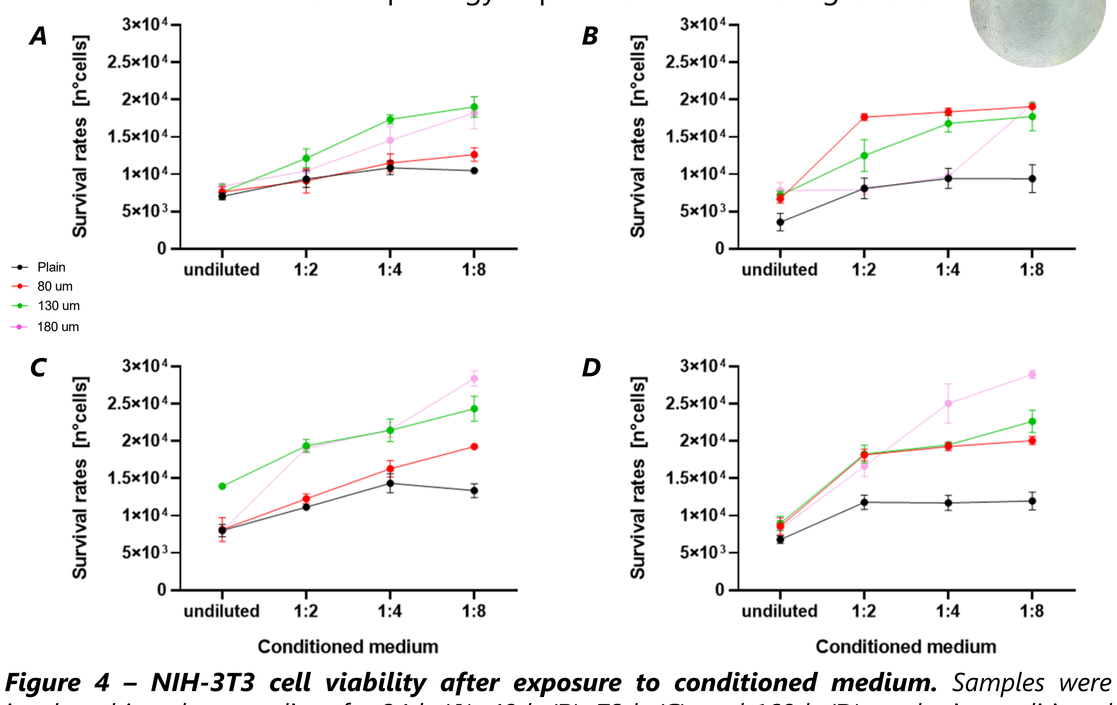


Figure 4 – NIH-3T3 cell viability after exposure to conditioned medium. *Samples were incubated in culture medium for 24 h (**A**), 48 h (**B**), 72 h (**C**), and 168 h (**D**) to obtain conditioned media, then applied to cells (undiluted and diluted: 1:2, 1:4, 1:8) for 24 h. Viability was assessed by Alamar Blue assay and expressed as survival rate (mean ± SD). On the right: representative optical microscopy images of treated cells.*

CONCLUSION

Cu-doped calcium phosphate bioresorbable glass proved biocompatible and resorbable, with surface microstructure significantly influencing cell response. These results demonstrate their potential for tissue engineering and resorbable photonic medical devices.

@BIO4_NANOLAB

TERMIS EU-Chapter 2026 PALMA DE MALLORCA 21-24 APRIL / SPAIN

Funded by the European Union NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani | PRIN | MUR Dipartimento di Eccellenza 2023-2027

termis EUROPE