Surface finishing of as-printed additively manufactured Ti-6Al-4V meshes for biomedical implants

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INTRODUCTION & AIM

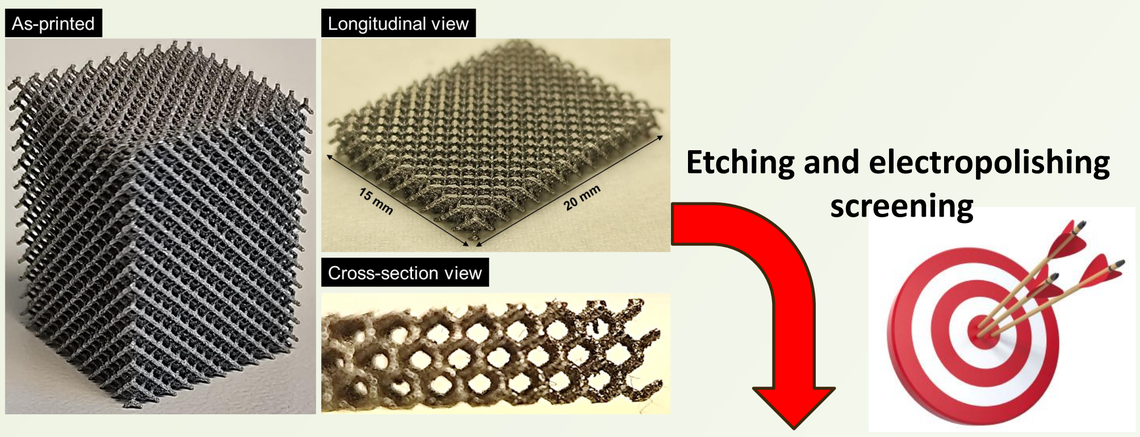
- **State of the art:** Additive manufacturing (AM) of titanium alloys enables the production of complex-shaped biomedical implants. However, their poor surface finishing compromise their biological performance [1].
- **Gap of knowledge:** The effects of different surface treatments on the biological implications of these surface defects remain unexplored [1].
- **Goal:** To enhance the cytocompatibility of mesh-shaped AM Ti by evaluating the impact of simple and cost-effective surface treatments, chemical etching, electropolishing, and their combination, on surface quality and cell–material interactions.

METHOD

- **Material**: Mesh-shaped Ti-6Al-4V alloy printed by Laser-Powder Bed Fusion.
- **Surface treatments**: Etching (HF/HNO_3 solution at different immersion times), electropolishing (NaCl-Ethyleneglycol solution at different voltages/times), and combining the best conditions.
- **Biomedical Properties**: Cytotoxicity assay (cell viability → PrestoBlue essay), and *in vitro* evaluation with Stem Cells (Apical Papilla (SCAP)).
- **Material characterization and surface-cell interaction**: Surface finishing, cell attachment/coverage (SEM), and roughness measurements (OM).

RESULTS & DISCUSSION

1. Surface treatments



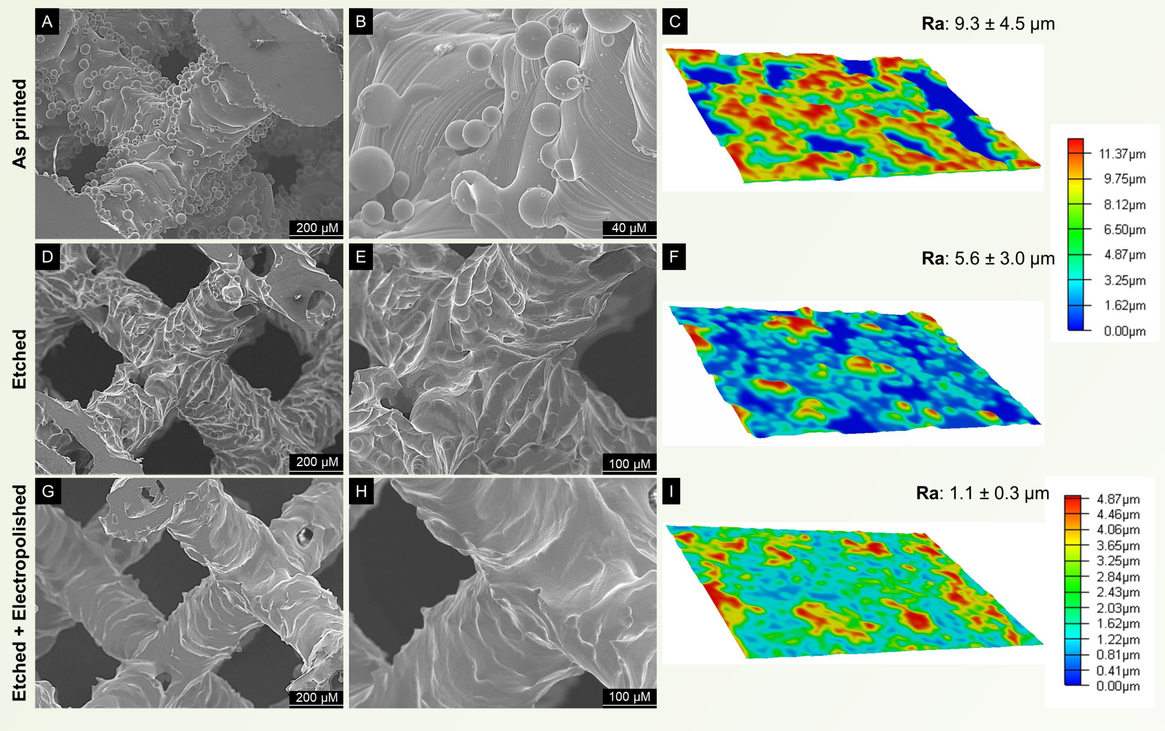
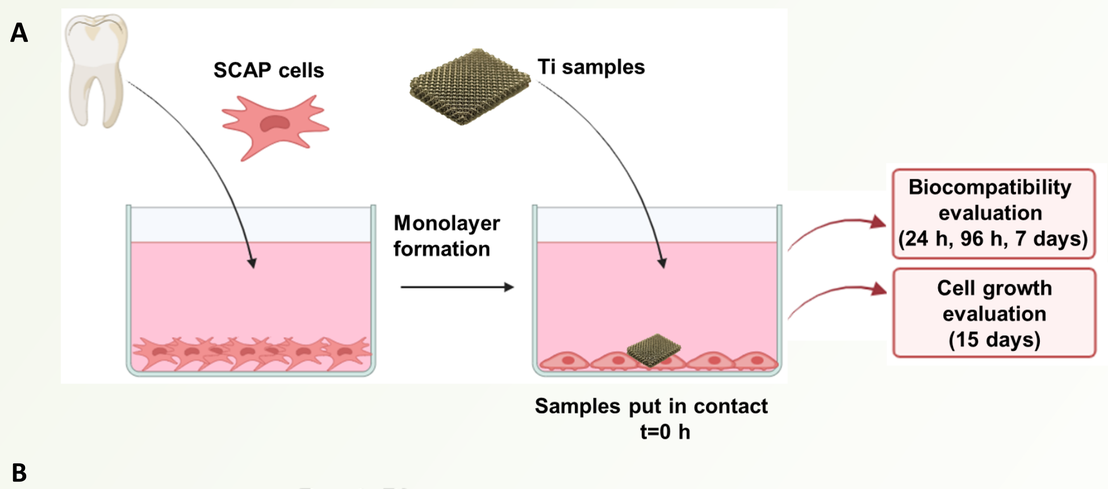


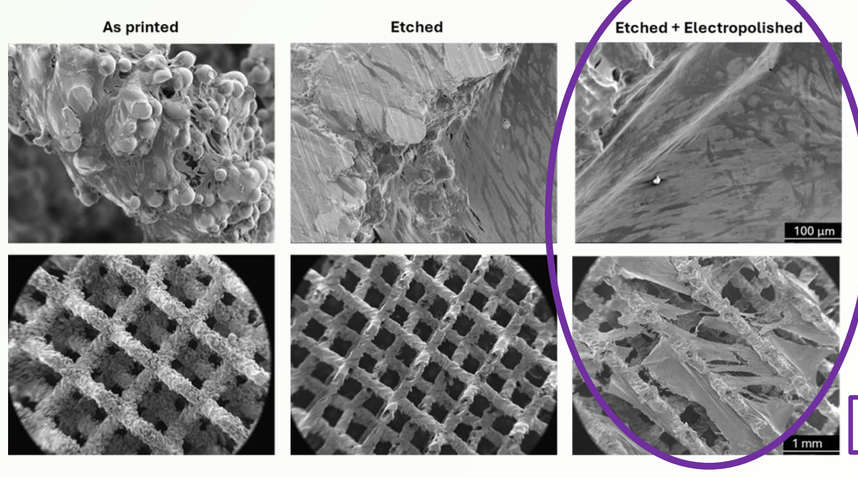
Figure 1. Scanning electron micrographs and 3D topographic map of (A-C) as-printed, (D-F) etched, and (G-I) etched + electropolished Ti-6Al-4V samples.

➢ **Combination of the best etching and electropolishing conditions (Etching + Electropolished sample) →**
↓ Surface roughness and unmelted particles removal.

2. *In vitro* evaluation



➢ **As-printed and surface-treated materials are biocompatible after 7 days of assessment.**



Cell monolayer!

Figure 2. (A) Direct contact assay scheme, (B) Prestoblue assay during 7 days of SCAP cells, (C) SEM images of growing SCAP cells on the materials after 15 days.

CONCLUSION/ FUTURE WORK

- **Surface treatments**: Combining etching and electropolishing on SLM-printed Ti-6Al-4V → reduce surface roughness, and remove unmelted particles.
- **Biomedical evaluation**: The combination of both surface treatments improve biocompatibility, support SCAP cell adhesion, and shows a superior cell coverage compared to the as-printed material.
- **Future work**: (i) Developments of new drug- and cell-loaded coatings to achieve homogeneous cell growth and drug delivery functionalities, and (ii) implementation of the proposed treatments for other Ti-based alloys.

REFERENCES/ACKNOWLEDGEMENTS

- **References**: [1] J. Li, et al., Recent Advancements in the Surface Modification of Additively Manufactured Metallic Bone Implants, Additive Manufacturing Frontiers 4(1) (2025) 200195.

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