Testing and Simulation of PLA and PETG AM Components for Biomedical Applications

TUS
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Aim of the Project

To investigate the mechanical behavior of FDM-printed PLA and PETG components with varying infill geometries and densities, using experimental tensile testing and finite element simulation, with a focus on applications in biomedical engineering.

Biomedical Applications of PLA / PETG

PLA – Biomedical Uses

- **Bone Scaffolds & Temporary Implants**

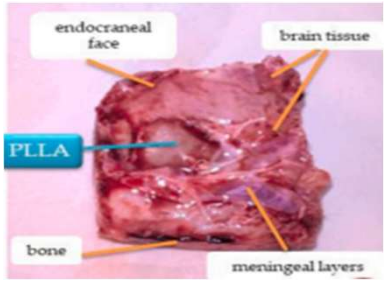
Biodegradable supports used for healing bone defects before dissolving naturally.

- **Drug Delivery Systems**

Enable time-controlled medication release inside the body.

- **Dental & Surgical Models**

Used for accurate, patient-specific guides in procedures.



Khouri, N.G., Bahú, J.O., Blanco-Llamero, C., Severino, P., Concha, V.O.C. and Souto, E.B., 2024. *Polylactic acid (PLA): Properties, synthesis, and biomedical applications – A review of the literature.* INCT-BIOFABRIS, Universidade Estadual de Campinas (UNICAMP) & University of Porto.

PETG – Biomedical Uses

- **Medical Device Housings**

Durable, sterilizable plastic for diagnostic and support tools.

- **Orthotic & Support Braces**

Lightweight and formable for custom-fit external supports.

- **Surgical Planning Models**

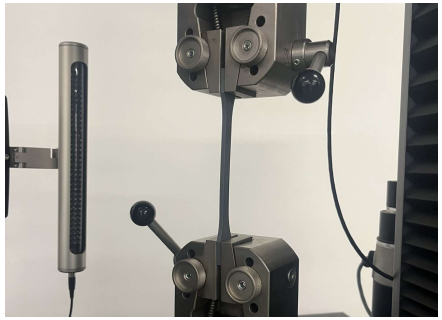
Visualize anatomy and guide complex procedures with precision.

Tensile Testing

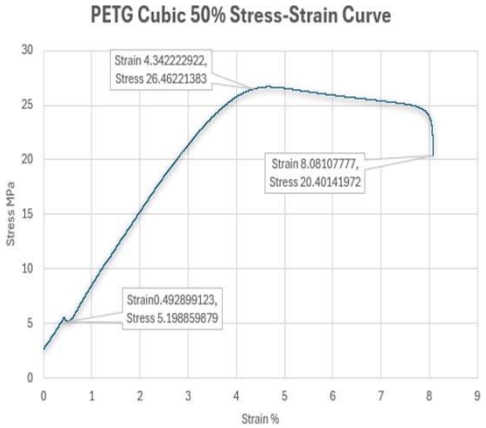
Tensile testing was performed on PLA and PETG specimens printed with varying infill geometries (Cubic, Grid, Honeycomb) at 30% and 50% densities.

Specimens were tested using ISO527-2 to determine:

- **Ultimate Tensile Strength (UTS)**
- **Strain at Break**
- **Limit of Proportionality**



The results were used to compare mechanical performance and to validate finite element simulation models.



Surface Roughness Testing

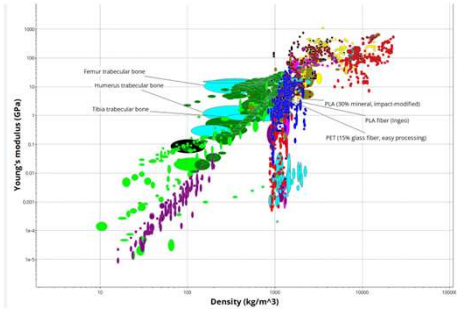
Surface roughness testing was carried out on all FDM-printed PLA and PETG specimens to evaluate their surface quality, which is important for mechanical performance and biomedical compatibility.

Key observations:

- Higher infill densities tended to reduce surface roughness.
- PLA generally had a smoother finish than PETG under the same print settings.

This data helps link print parameters to both functional performance and potential biomedical applications.

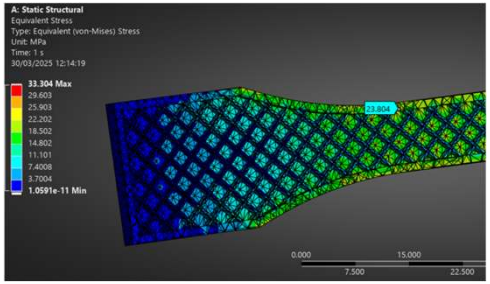
Material Selection

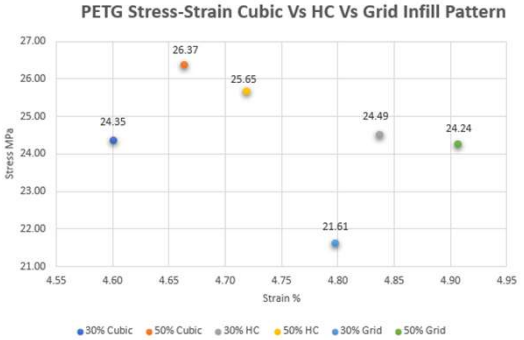


Finite Element Analysis

Finite Element Analysis was used to simulate the tensile performance of FDM-printed PLA and PETG specimens. Using ANSYS Mechanical, tensile loads were applied to 3D models.

Results





Conclusion

- PETG samples had greater tensile strength and elongation than PLA across all infill geometries.
- Despite having lower UTS, PLA is more biocompatible and suitable for degradable or implanted biomedical devices.
- 50% Honeycomb infill had the highest UTS and Strain for both PLA & PETG.

Acknowledgments

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