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MDPI

Adhesion of PJM printed MED610 objects on textile substrates

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Introduction & Aim

- 3D printing on textiles has evolved over the past decade with current research focusing on mechanical properties of polymer/textile combinations
- Adhesion between polymers and textile substrates remains problematic, particularly with fused deposition modelling (FDM)
- Resin-based 3D printing, including stereolithography (SLA) and PolyJet modelling (PJM), are promising alternatives

→ This research presents the first study of PJM printing with MED610 resin on different fabrics.

→ Initial experiments explore how different textile substrates affect the porosity of the MED610 surface, with potential applications in tissue engineering and biotechnology.

Materials and Methods

Textile fabrics under examination

Sample	Hydrophobicity	Thickness / mm	Apparent density / (kg/m³)	Porosity / %
PES "micropeach"	Hydrophobic	0.38	334	78
Cotton	Hydrophilic	0.34	421	72
Linen	Hydrophilic	0.54	363	74
PES plain weave	Hydrophilic	0.32	522	65
PES twill 2/1	Hydrophilic	0.32	581	61
PES Leno	Hydrophilic	0.48	377	75

3D Printing and Characterization

- Equipment – PJM printer Connex 350 (Stratasys)
- Material used – MED 610 resin (Stratasys, Eden Prairie, MN, USA); certified biocompatible according to ISO 10993-1:2009
- Samples – rectangles of 25 mm x 10 mm for adhesion tests
- Water contact angles – measured 5x using USB microscope
- Adhesion tests using Sauter FH2K universal test machine (DIN 53530; evaluated according to ISO 6133 standard)
- Confocal laser scanning microscopy (CLSM, VK-8710, Keyence, Neu-Isenburg, Germany) and Image J software

Results

Water contact angle

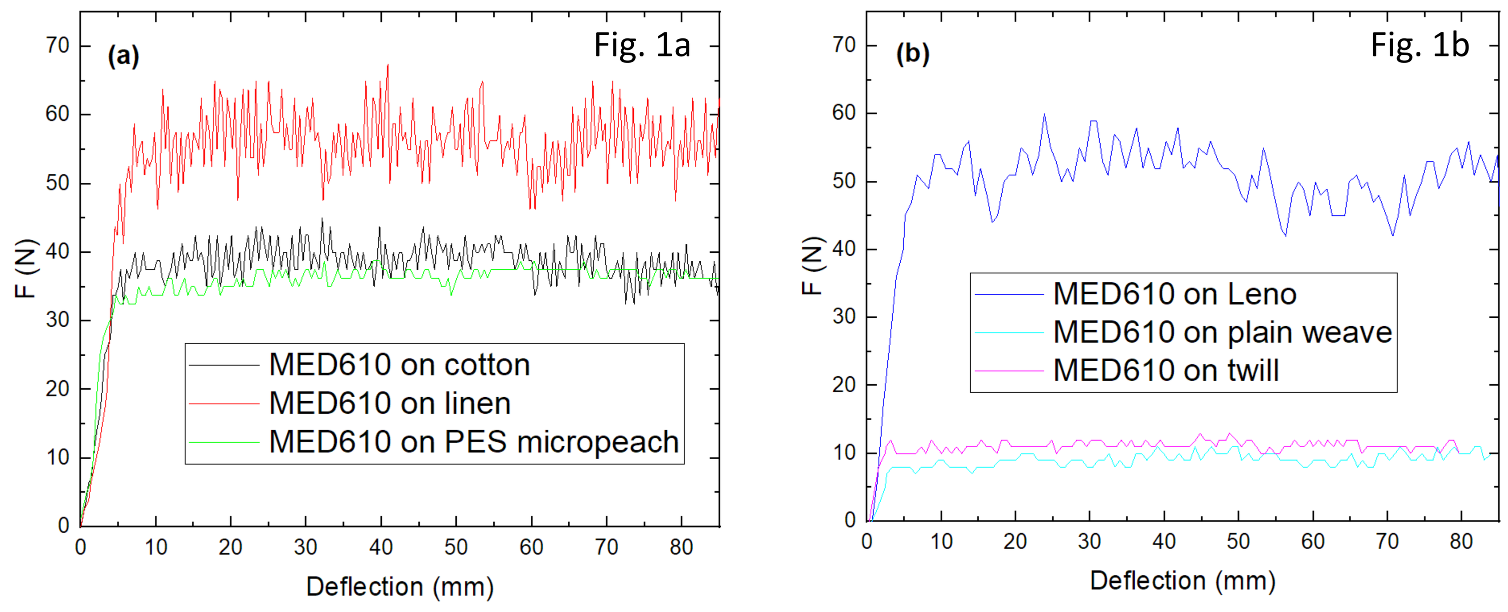
- The front side of PES micropeach had a contact angle of (123 ± 6)°, while other fabrics were hydrophilic.

→ Adhesion expected to be lowest on micropeach, according to the Korger rule [1]

Adhesion tests

- Highest adhesion forces on linen with more variation, while PES micropeach shows minimal variation (Fig 1a);
- Adhesion values are low on plain weave and twill but higher on thicker leno fabric (Fig 1b).

→ Attributed to different surface morphologies and thickness



Results (Continued)

→ Adhesion also affected by different evaluation methods, Fig. 2

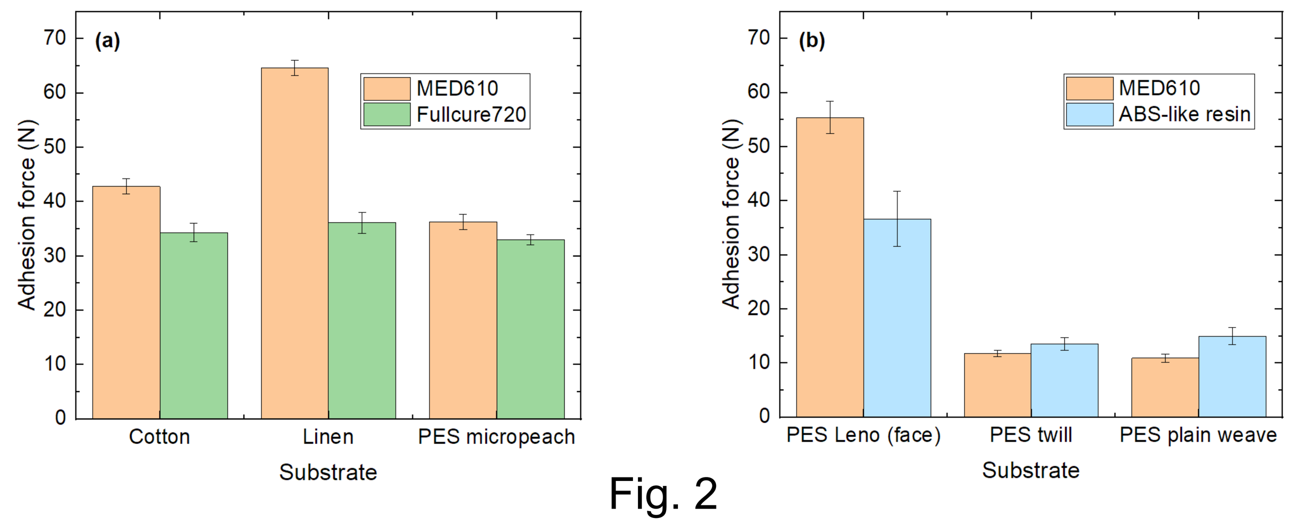
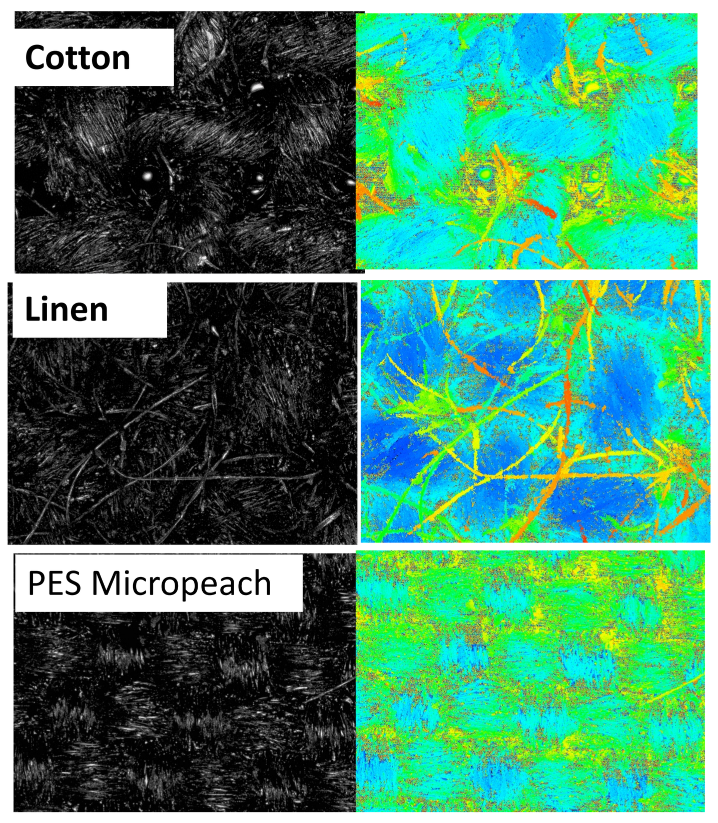


Fig. 2

Confocal laser scanning microscopy

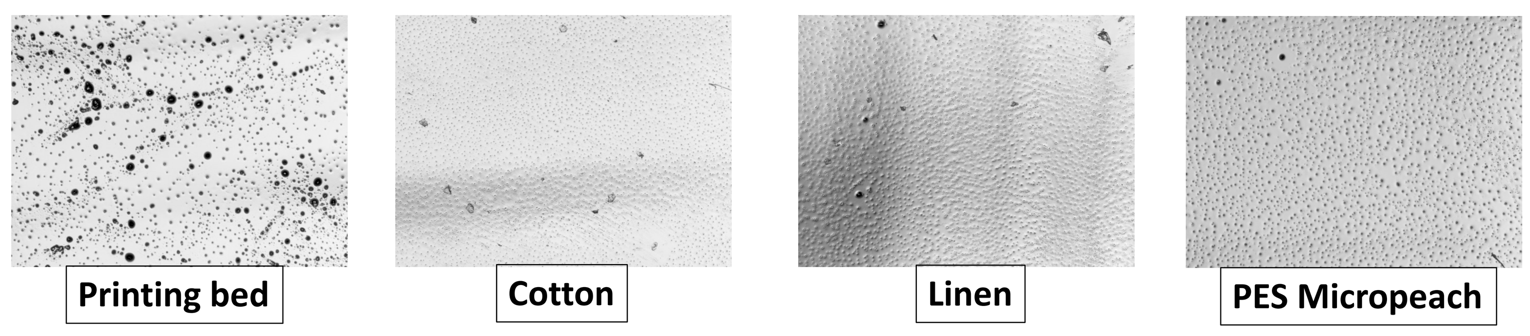
- CLSM images on the back of MED610 detached from different textile fabrics, showing the optical appearance (left panels) and the heights (right panels). In the latter, blue shows the lowest areas and red the highest ones.



- Woven structure clearly visible for all three fabrics
- Visible differences between cotton (showing a few protruding fibers, visible as red-orange colors), linen (showing much more fibers), and PES micropeach (without fibers).

→ Adhesion supported by larger amount of fibers.

- CLSM of MED 610 printed on different surfaces showed that there are more large holes visible on the surface of pure MED610.
- Printing on textile fabrics leads to more small holes; with the optically most homogeneous surface and the least large holes on cotton and linen fabrics.



Literature

[1] Korger, M., Glogowsky, A., Sanduloff, S., Steinem, C., Huysman, S., Horn, B., Ernst, M., Rabe, M. Testing thermoplastic elastomers selected as flexible three-dimensional printing materials for functional garment and technical textile applications. *Journal of Engineered Fibers and Fabrics*, **2020**, *15*, 1558925020924599.

[2] Kozior, T., Ehrmann, A. First Proof-of-Principle of PolyJet 3D Printing on Textile Fabrics. *Polymers*, **2023**, *15*(17), 3536.

Conclusion

- Highest adhesion values were found for the most hydrophilic and hairy linen woven fabric.
- Good adhesion could be correlated with thick hydrophilic fabrics with a low apparent density.
- Less large holes on MED610 printed on cotton and linen may support the use of MED610 in tissue engineering.

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