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Additive manufacturing of PLA microneedles for transdermal drug delivery

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As physical permeation enhancers, microneedles (MNs) can modificate *stratum corneum* by creating microchannels, that are large enough to enable drugs, including macromolecules, to enter the skin while being small enough to avoid pain, irritation, and needle phobia [1,2]. Great emphasis is placed on the production process of microneedles itself, the selection of the most suitable materials as well as their shape, density, and size. This work aimed to fabricate biodegradable PLA MNs using additive manufacturing, more precisely fused deposition modeling (FDM) technology, and investigate the effect of varying geometry and print settings on the printed MNs in order to develop microneedles of optimal shape, density, and height.

Ultimaker 5S 3D printer (Ultimaker, Netherlands) was used to print triangular and cylindrical MNs with different heights (0,6 mm, 1,2 mm, and 1,8 mm) and different number and orientation of single arrays on the base (5x5, 3x3, 1x5) using 2.85 mm PLA filament (3D Republika, Serbia). The results showed the ability of Ultimaker 5S to successfully print MNs with different shapes, where the triangular shape was chosen to be more acceptable for transdermal delivery. 1.8 mm height was chosen as the optimal height for the MNs, while the 5 x 5 orientation of single arrays on the base resulted in more accurately printed MNs without a lot of waste material between the needles. Based on the results obtained, it can be concluded that FDM printing parameters can easily be adjusted to develop MNs of optimal shape, density, and height for transdermal drug delivery.

References

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