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Triply Periodic Microneedle Array Patches (TP-MAPs) with Continuously Curved Micro-Networks for Capillary-Driven Drug Delivery and Intradermal Fluid Collection

Researchers in the DeSimone Research Group at Stanford University have developed manufacturing-ready robust triply periodic (TP) microneedle array patches (MAPs) with optimized fluid transport, payload capacity, and scalable manufacturability for intradermal drug delivery and diagnostics. Conventional microneedles and MAPs offer minimally invasive advantages over intravenous injection, but are limited by manufacturing constraints that preclude complex internal architectures. TP-MAPs advance microneedle design by replacing conventional solid or strut-and-node lattice geometries with mechanically robust triply periodic, continuously curved minimal surfaces (TPMS) for superior capillary wicking, interstitial fluid (ISF) collection, and multifunctional payload delivery produced via commercially validated Continuous Liquid Interface Production (CLIP) manufacturing.

Stage of Development – Prototype
TP-MAP production via carbon CLIP printers is ready to be scaled up for testing and optimization.

Applications

- Intradermal delivery for:
  - Pharmaceuticals and vaccines
  - Diagnostics and monitoring
  - Cosmetics and dermatological applications

Advantages

- **Excellent capillary wicking** with high surface area per volume for **immediate payload delivery**
- **Versatile, supports multiple functionalities** including simultaneous delivery and sampling, spatially programmed release of multiple agents, or integration with **wearable electronics** and sensing components
- **Robust**, high fracture resistance and uniform stress distribution
- **Commercially scalable** with improved Continuous Liquid Interface Production **(CLIP) printability**

Innovators

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