DISSOLVING MICRONEEDLE VACCINE PATCH

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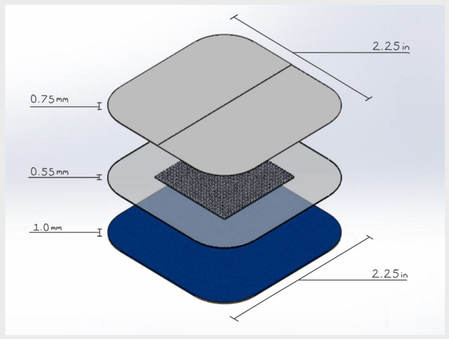
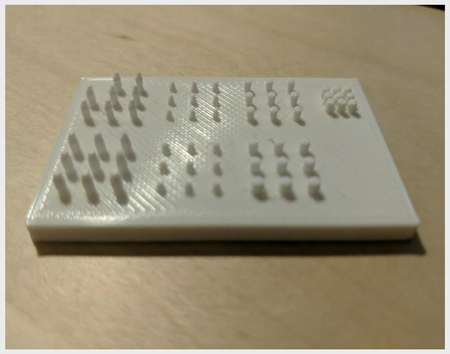
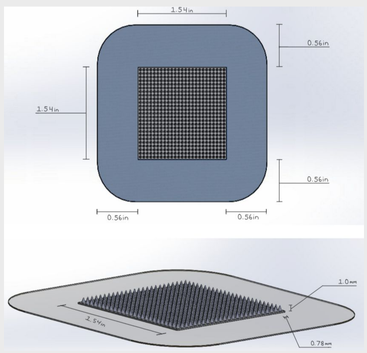
Introducing T.I.P.: the Transdermal Inoculation Patch that makes your vaccination dreams come true.

You won't have to worry about the T.I.P. of this needle!







MODELS

Flux/Diffusivity

- The average flux inside the skin is a strong function of the drug properties or diffusivity.
- We could keep our needle matrix parameters constant for any vaccine type; we only needed to adjust the concentration of the vaccine in the needles.
- Using a final drug concentration in the tissue of 2.32 g/m^3 (value obtained from literature), we determined that the vaccine diffusion time is about 2.5 minutes (210 seconds).

Needle Diameter

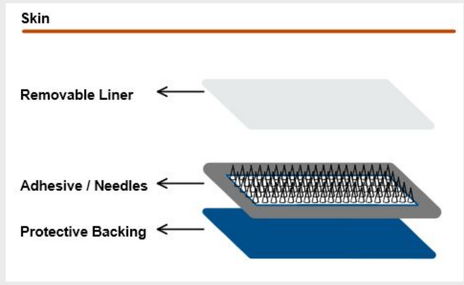
- A height of 2 mm was chosen because it was the depth needed to penetrate the dermal layer where optimum transfer can occur.
- Surface area to volume ratio: SA/V = 6.4266 * d$^{0.934}$ (units of 1/length)
- Final needle diameter is 0.78 mm.

Adhesion (Peel Strength)

- Compared three types of medical grade adhesives—synthetic rubber, acrylate, and soft silicone gel—and evaluated their peel adhesion, sterilisation compatibility, breathability, repositionability, initial tack, and skin trauma upon removal. Soft silicone gel exhibited the best breathability, good tack, and low skin trauma upon removal. Therefore, soft silicone gel was the chosen material.
- Compared three types of silicone gel: Silbione RT 4717, Silbione RT 4642, and Silpuran 2130. Silbione RT 4717 had the highest peel strength of the three, so it was the strongest type. Therefore, Silbione RT 4717 was chosen as the adhesive to use for the vaccine patch.

PRODUCT OVERVIEW

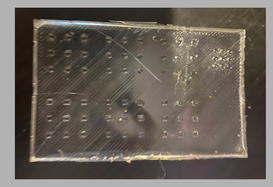
- **What gives the vaccine patch the ability to solve the problems of current vaccination techniques, particularly the use of needles?**
  - The microneedles are made of non-toxic polymer that dissolve in the skin.
  - The microneedles access viable skin tissue but do not stimulate nerve endings.
  - The patch is small enough to apply to oneself.
  - The patch needs no special disposal.
- **Final product dimensions:**
  - 25 by 25 microneedle matrix (625 microneedles)
  - Needle height of 1 mm, needle diameter of 0.78 mm
  - Patch side length is 2.25 in. and is 2 mm thick
  - Package is 2.5 in. by 2.5 in., has an outer thickness of 0.67 in. (17 mm), an inner thickness of 0.43 in. (11 mm), and has 0.12 in. thick walls
- **Final design components:**
  - Removable liner- Super calendered kraft paper
  - Dissolving microneedle matrix- Polyvinylpyrrolidone
  - Adhesive- Silbione RT 4717
  - Protective Backing- Polyethylene and fabric canvas



DESIGN PROTOTYPES

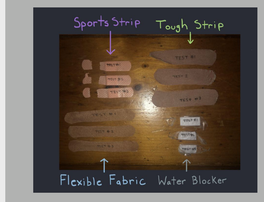
Dissolving Microneedles

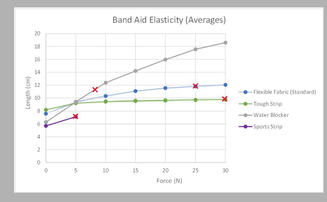
- The first prototype examined the geometry and material of the dissolving microneedles
- Two main principles explored:
  - Diffusion dominates mass transfer
  - Poly vinyl pyrrolidone (PVP) can be loaded with drugs and dried into various shaped microneedles
- The picture below depicts aqueous PCP poured into the silicone mold to create a dissolving microneedles



Protective Backing

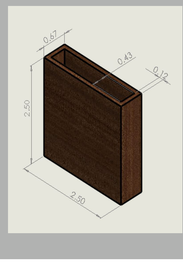
- The second prototype examined what protective backing material we would use for the vaccine patch.
- We determined material durability via an elasticity and a shear stress tests using four different types of protective backing band aid material.
- In both experimental tests the most durable band aid was the tough strip which is made out of a combination of polyethylene and canvas fabric.





Packaging

- The third prototype created a package for the vaccine patch and focused on keeping the vaccine at the appropriate temperature while protecting the microneedles.
- Used cardboard that was 3 mm thick, insulation that was 4 mm thick, and the 3D printed patch that was 2 mm thick.
- Can fit about 800,000 to 1,000,000 packages in an 8 ft. by 8 ft. by 40 ft. shipping container.



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