Flow Visualization on the Drug Formation above the Microneedle Surface

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Microneedle (MN) patches have been developed as a painless, minimally invasive transdermal drug delivery platform. In order to successfully deliver a broad range of drugs, different microneedle fabrication techniques combined with drug loading methods are under development.

In this study, a typical test microneedle patch has the area 1 cm^2 and 289 needles. The height of each needle is 600 μm and the base diameter is 300 μm. We selected two ways to load drugs on the MN patch, including both dropping and dipping techniques to coat the drug solution on the patch. In the dropping process, we first determine the desired amount of the fluid, and then we use a syringe to inject a drop of liquid onto the designated area of the patch. Finally, we study the drying process with different fluid properties under room temperature.

The results in Fig. 1 indicate that during the drying process, the fluid contact lines will pin on the needle surface, and then the meniscus will start to change dramatically. That is to say, the dried drug will spread from the pinned positions to the bottom area. The results in Fig. 2 indicate that when drying under the same condition, even with the same surface tension, the drying patterns may be different owing to different fluid viscosities.

The analysis on the dip coating process is underway. A dip coating device was built, and the experimental set-up is shown in Fig. 3. We are also developing a mathematical model to predict the amount of drug remaining on the microneedle patch.

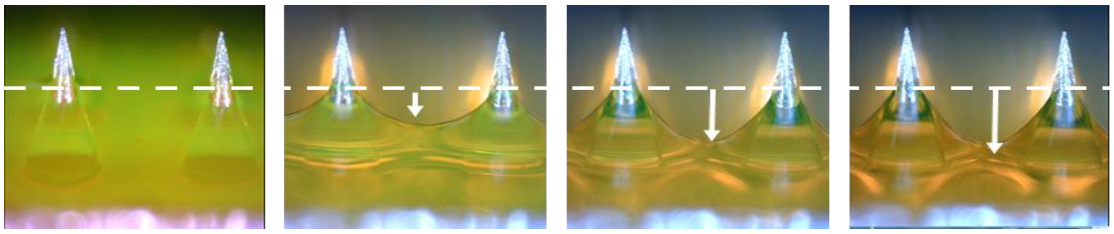

Fig. 1-Visualization on the drying process (Viscosity: 30 mPa·s, surface tension: 40 N/m, room temperature)

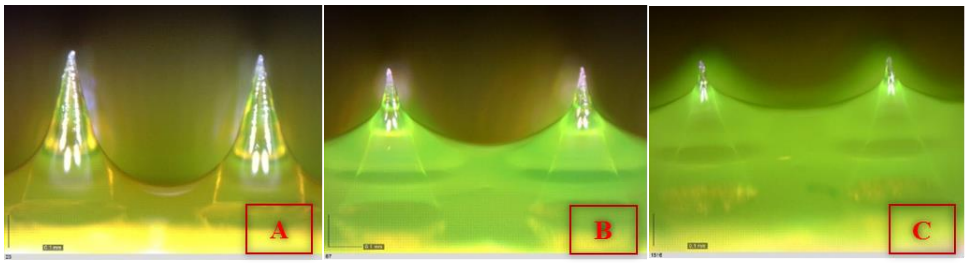

Fig. 2- Fluids with different viscosities for drying study: (A) Surface tension: 40 N/m, viscosity: 30 mPa·s (B) Surface tension: 40 N/m, viscosity: 50 mPa·s (C) Surface tension: 40 N/m, viscosity: 150 mPa·s

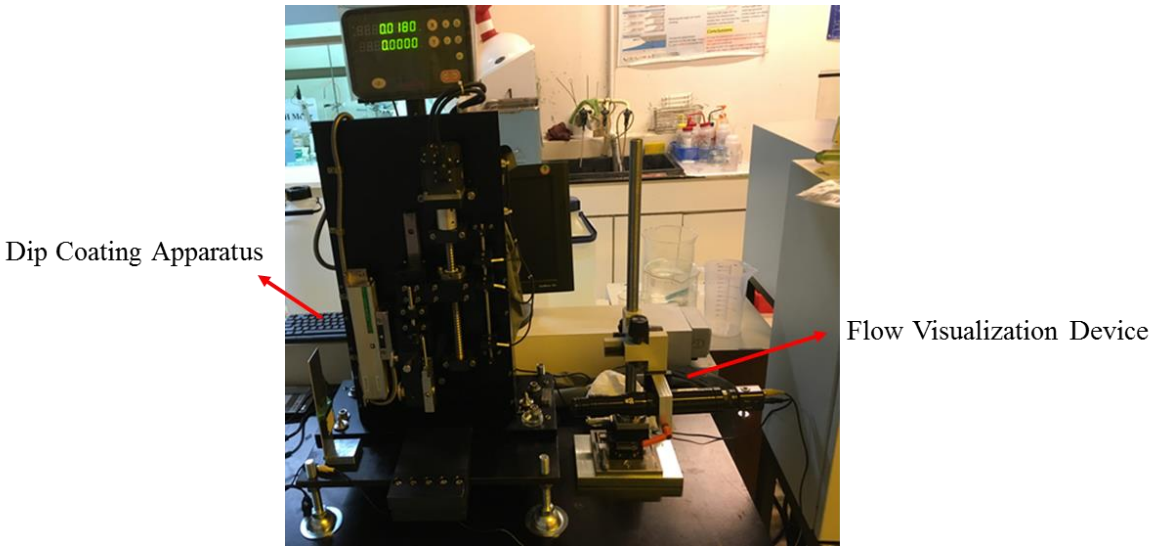

Fig. 3- Dip coating and flow visualization systems