A Quick, Reliable, and Versatile Method for Creating Microneedles for Bio-Harvesting

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The extension of semiconductor processing technologies beyond integrated circuits has led to the development of small, micron-sized engineered devices for medical applications. Among these devices are microneedles, micron scale needles whose dimensions are tailored to allow for penetration of the stratum corneum, into the dermal and/or epidermal layers, but not stimulate nerve response. One of the current drawbacks to fabrication of microneedles is the intensive processing needed to create microneedles with through holes, typically involving multiple deep reactive ion etching (DRIE) processing steps, involving the use of large capital equipment, and taking several days to complete. Using other processing semiconductor technologies, we have developed a variety of techniques for fabricating microneedles and integrated arrays of microneedles based on the use of a the photo-definable glass, Foturan®.

Current progress on using microneedles has focused on their use as bio-harvesters, devices allowing for the extraction of interstitial fluid from biological organisms, such as mammalian sampling or fluid removal from plants for use as a fuel source for a micro fuel cell. This research is being conducted as part of Sandia National Laboratories' work on a bio micro fuel cell. In this presentation we will present two major types of microneedles our team has fabricated, anisotropically and isotropically etched. We are able to control sidewall shape by varying the aspect ratio of the device and the UV source used to expose the Foturan®. Typical process time in fabricating these microneedles is 2-3 days, with the rate-limiting step being two-8 hour bakes. Total attendance time by a processor is less then half a day. Part yield is greater then 90% over anentire 100mm wafer. In addition, the Foturan parts can be used as molds for hot embossing. We will report on techniques to produce these microneedles in bio-compatible plastics.

We will also present extraction studies using these microneedles for glucose harvesting. For these studies, porcine skin was used as a human skin model. Tests were conducted using a Franz diffusion cell. The flux of glucose transport across the porcine skin, for the negative control, was 0.0012 mmol/min/cm^2 (Figure 3). The flux of glucose transport across the porcine skin, with the microneedles, was .609 mmol/min/ cm^2, 500 times greater then the transport without the microneedles in place.

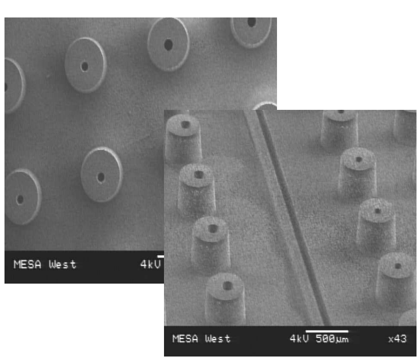

Figure 1: Fabrication of Anisotropically Etched Microneedles With Through Holes

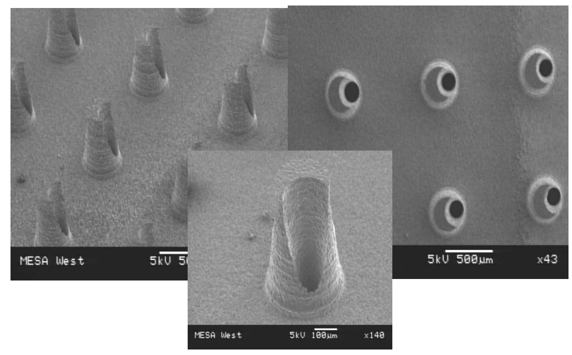

Figure 2: Fabrication of Isotropically Etched Microneedles With Through Holes

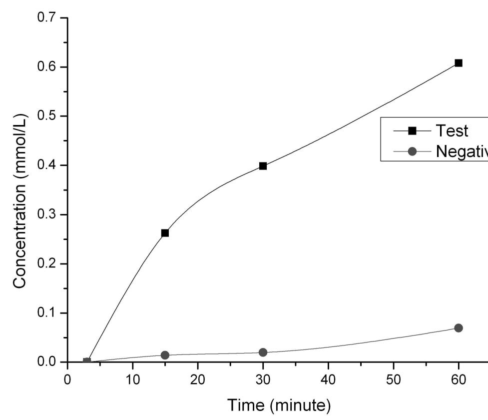

Figure 3: Glucose Extraction Rates Through Porcine Skin With and Without Microneedles

Acknowledgement

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