Microneedles for *In-Situ/In-vivo* Electrochemical Sensor Applications

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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 designed to penetrate the stratum corneum and allowing access to bodily fluids. Using semiconductor technologies, we have developed a simple technique for fabricating microneedles and arrays of microneedles that can serve as microelectrodes allowing for in-vivo electrochemical sensing. The process developed by us is based on semiconductor processing technologies and the use of a photo-definable glass, Foturan®.

Shown in Figures 1a-1d are examples of four different gold microneedle arrays. As seen, the geometry of the needles, including length, diameter, needle density, etc., can be easily tailored, allowing for a high degree of flexibility and tailoring of the electrochemical system.

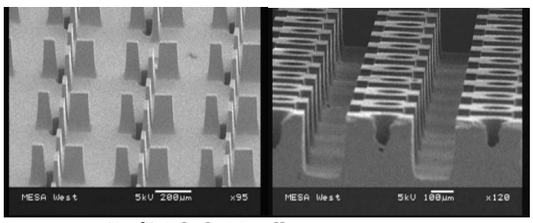

Figure 1a (Left) Blade Needles.
Figure 1b (Right) Hollow Blunt Needles

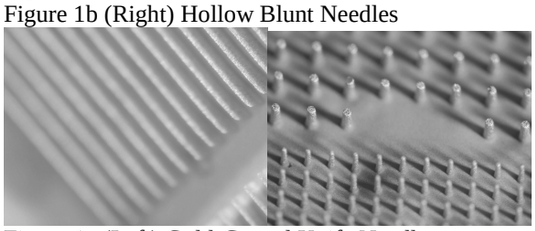

Figure 1c (Left) Gold-Coated Knife Needles
Figure 1d (Right) Gold-Coated Pointed Needles

We have also completed an initial series of in-vitro sensing experiments using porcine skin and some redox couples having well defined electrochemical behavior. Shown in Figures 2 and 3 are examples of some of this work using ferricyanide and quinone, and shown in Figure 4 is a picture of the microneedle array that was used to collect this data.

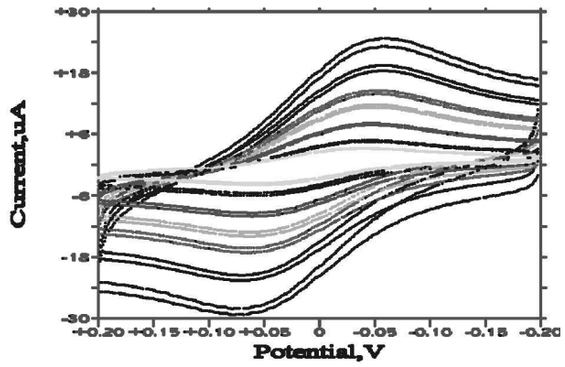

Figure 2 Voltammetric response of microneedle electrode array inserted into pig skin containing ferricyanide. The voltammagrams were collected at various scan rates up to 800 mV sec^{-1}, and two cycles were collected for each.

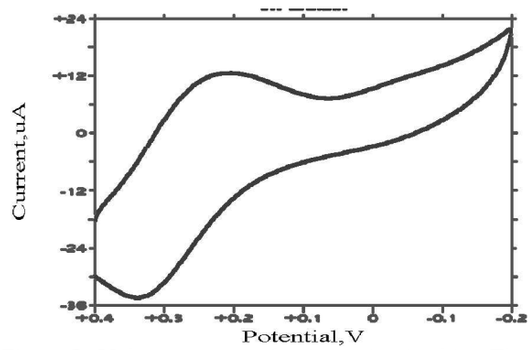

Figure 3 Voltammagram of quinone in pig skin. The scan rate used was 100 mV sec^{-1}.

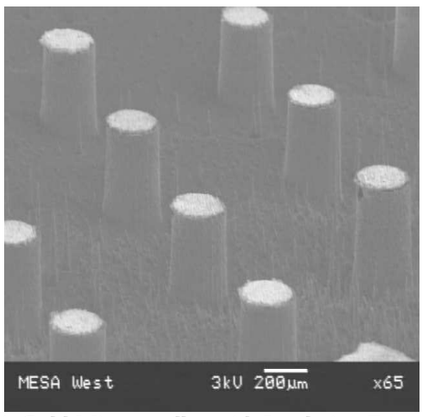

Figure 4 Gold Microneedles with Insulating Foturan® Sheath for pair-wise addressing.

As seen, the electrode arrays consist of two 4 by 11 gold arrays positioned in close proximity to one another, with one array serving as the working electrode and the other array acting as the counter and pseudo-reference. Although two arrays are used here in a two-electrode configuration, the individual microneedles can be addressed pair-wise, and so in this configuration will allow for fabrication of 44 discrete electrode pairs in a device size of approximately 0.5 cm by 1 cm.

Acknowledgement

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