



# Final Report for AASERT-ISAS Contract

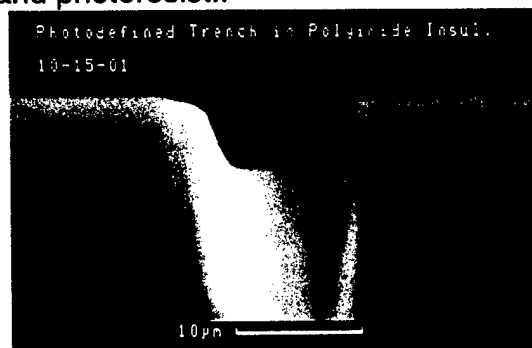
Period: 8/98 - 5/02

**Goals:** Under the AASERT-ISAS project, the Center for Engineering Design sought to refine processing techniques associated with cylindrical microfabrication and use these processes to assemble a functional microelectrode fabricated on a cylindrical substrate. Processes such as small feature patterning, passivation layer application, and connection methods were investigated.

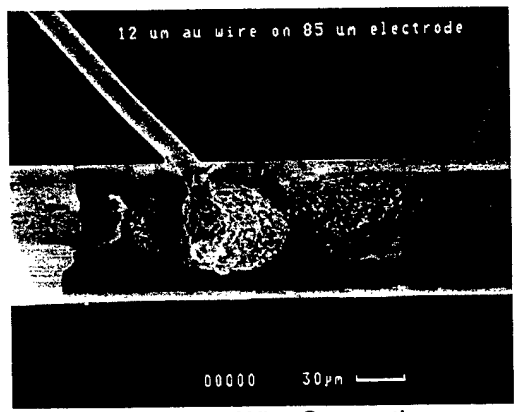
## Completed Milestones:

**Patterning** - In order to produce first-generation electrical and mechanical devices on a cylindrical substrate, a target linewidth of 10  $\mu\text{m}$  was determined based on the available surface area of a 100  $\mu\text{m}$  diameter cylinder. The primary improvement was in the optics and exposure system. When using a helium-cadmium (HeCd) laser as a direct-write exposure tool, optics must be selected to allow maximum transmittance of the critical wavelengths. Two set of optics were employed depending on which spectral band of the HeCd laser was to be used for exposure. Based on the Gaussian-like intensity distribution, linewidths in photoresist could be controlled by carefully modulating the laser power incident at the substrate. This was achieved by the addition of conditioning pre-optics along with the installation of a precision laser power meter at the laser output head. By adding these features, we were able to consistently produce linewidths smaller than the target linewidth of 10  $\mu\text{m}$ .

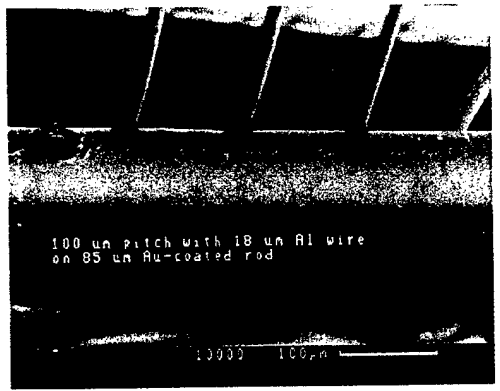
**Passivation** - Passivation layers are required in most microelectromechanical systems (MEMS). For multi-level electronic systems, the passivation layer must isolate the top layer of a electrical circuit from the underlying layer of the circuit while passing power or signals between the layers at specified points. In mechanical systems, a passivation layer can protect parts from the intrusion of dust, abrasions, or oxidation. In electrode technology, we required a definable passivation layer which could protect the circuit from a warm saline environment, while passing current to the external environment at pre-defined points. A positive-tone photo-definable polyimide polymer was selected after experimentation with other insulating materials such as silicon dioxide, parylene, negative-tone polyimide, and photoresist..



Connectors - Any electrical microsystem should have connectors to allow for the input of power or signal transmittance. We used gold wire as the lead wires and connected them to the cylindrical system using two bonding methods, silver epoxy bonds and ultrasonically-applied wire bonds. After comparing the time required for each bond, the resulting impedance of each bond, and the yield rate of the two systems, we adopted the wire bond process.

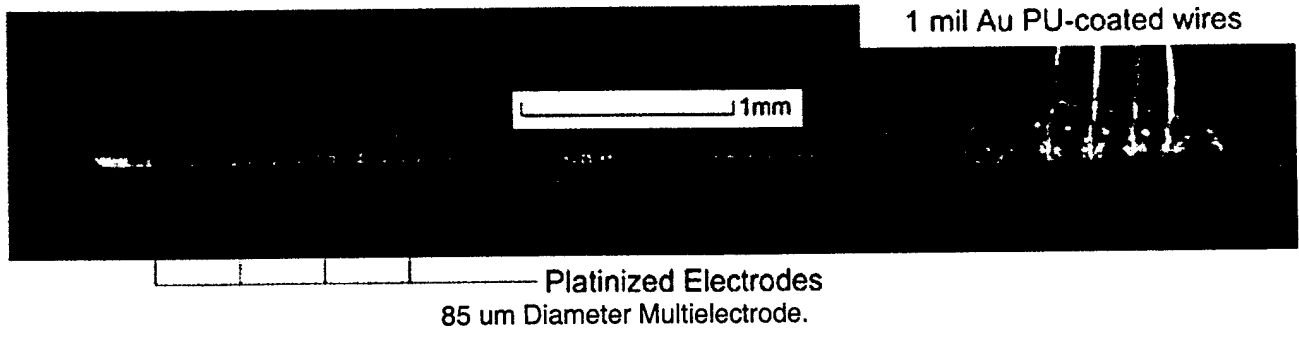


Silver Epoxy Wire Connections



Tangential Wire Bond Connections

Functional Microelectrode - By combining the improved processes, we constructed a functional microelectrode capable of passing current pulses to tissue consistent with the requirements and specifications of neural prosthetic stimulation electrodes. Figure 4 shows the electrode which required ten micron trace widths to conduct current, the photo-defined polymer for interfacing with a biological environment, and wire bonded gold wires transmitting the current from voltage-controlled current sources. This design has proved reliable in a warm saline environment.



The findings discussed in this report will be submitted for journal publication at a later date in order to share the progress with the remainder of the MEMS community.