Focused Gold Ion Implantation Into Insulators For Conducting Wires

T. Brintlinger
Nanoscale Materials Section
U.S. Naval Research Laboratory
Washington, DC 20375
todd.brintlinger@nrl.navy.mil

With the advent of non-Ga ion sources in commercial focused-ion-beam (FIB) systems, new possibilities have arisen for lithographic devices. We demonstrate that focused gold ions can be directly implanted into silicon nitride to form conducting wires. The focused gold ion beam is formed from a binary alloy AuSi source with a deep eutectic temperature, where the gold ions are sorted from the silicon ions with in an ExB filter. Using a 15 pA beam, single-pass lines (dose 1.0-1.5 nC/cm) are written to create several wires in the gap between existing gold electrodes on a silicon nitride membrane, as seen in Fig. 1. To allow for overlap between the deposited gold wires and the electrodes, the lines are written on top of the existing gold electrodes, as well as in the gap, giving rise to rapid gold-on-gold sputtering in the electrodes, but leaving behind the aforementioned gold wire in the silicon nitride. Full-width, half-max linewidth of wires is 110-140 nm. Atomic force microscopy reveals significant ion sputtering in existing gold electrodes, as already seen in scanning electron microscope, but shows that implanted gold ion wires exist in subsurface with minimal topographic distortion to silicon nitride membrane. Voltage sweeps reveal linear, length-dependent, and disappointingly small currents (~nA) passing through the gold wires, as seen in Fig. 2. However, no post-deposition treatments have been applied, so it is possible that annealing or self-heating may improve the performance, and thus utility, of these implanted gold wires.

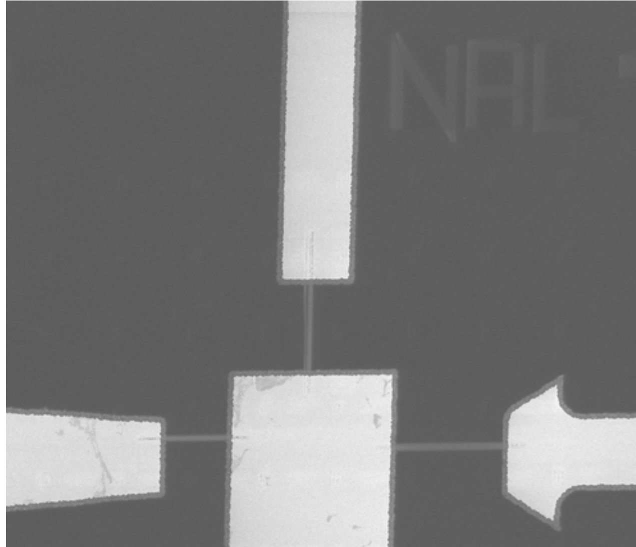

Figure 1: Scanning electron micrograph of focused gold ion wires implanted in silicon nitride membrane between existing gold electrodes.

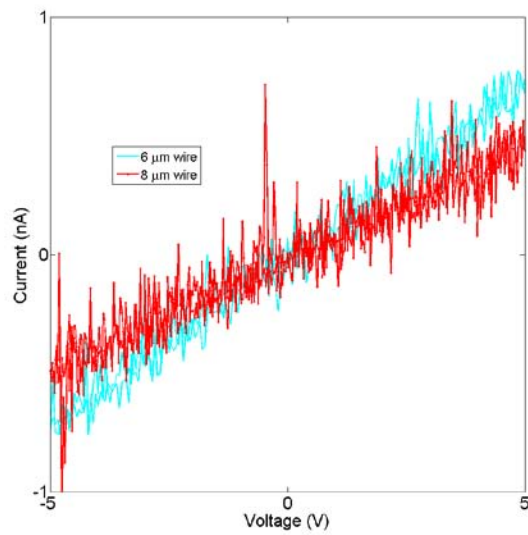

Figure 2: Current vs voltage for implanted gold ion wires.