A MEMS-relay for Power Applications
A.C. Weber, J.H. Lang, A.H. Slocum
Sponsorship: NSF Collaborative Research: Atomic Plane Electrical Contacts

Contact travel and heat dissipation are important requirements of electrical power switching devices such as MEMS-relays and MEMS-switches. Whereas low-power MEMS-based RF switches have been vigorously studied, few studies have been reported on high-power MEMS-relays. This paper presents a MEMS-relay for power applications. The device is capable of make-break switching; has large contact travel, on the order of 10’s of µm; and has low contact resistance, on the order of 120 mΩ. Testing has demonstrated current carrying capacity on the order of several amperes and hot-switching of inductive loads, on the order of 10mH, without performance degradation.

The MEMS-relay, shown in Figure 1a, is bulk micromachined in (100) silicon and bonded to a glass substrate. Anisotropic etching is used to fabricate the oblique and parallel (111) contact surfaces, having nanometer-scale surface roughness [1]. Figure 1b shows a cross section of the open fabricated contacts. An offset between the wafer-top and the wafer-bottom KOH masks produces the contact geometry shown. The silicon contact metal surfaces are created by evaporation and electroplating with a conductive film, shown in Figure 1c. A thermal oxide layer provides insulation between the actuators and the contacts. Deep reactive ion-etching (DRIE) is used to pattern a parallelogram-flexure compliant mechanism and a pair of rolling-point “zipper” electrostatic actuators [2]. Nested masks are used to pattern both wafer-through etches. Figure 2 illustrates the process used to fabricate the device.

**REFERENCES**


A Silicon-etched, Electrical-contact Tester
Sponsorship: NSF Collaborative Research, Atomic Plane Electrical Contacts

We are developing a bulk micromachined contact tester to investigate the electro-tribological performance of micro- and nano-structured planar electrical contacts [1]. The test device features parallel, planar, nanometer-scale surface roughness contacts etched in silicon coated with thin conductive films. Contacts used in microsystems, probes and interconnects are subject to heat dissipation and to electro-mechanical tribological effects. With an understanding of how nanoscale surface and subsurface material structure affect electrical contact resistance and mechanical contact wear, a deterministic manufacturing process could be developed to design electrical contacts from crystalline plane surfaces as potential high performance contacts for MEMS devices and related applications.

The microfabricated contact tester, shown in Figure 1 and in Figure 2, consists of a pair of parallel planar contact surfaces with nanometer roughness patterned onto two (100) Si substrates. Anisotropic etching is used on one of the substrates to create a membrane that serves as a compliant mechanism for the contact tester. A thin conductive film, i.e., Au, is patterned onto the contacts in a Kelvin configuration. The two-piece tester architecture allows for inspection of the contacts before, during, or after testing without destruction of the test device. In one embodiment of the tester, a quasi-kinematic coupling enables the alignment between the substrates while providing the initial gap between the contacts. Similar quasi-kinematic designs fabricated in silicon substrates have reported repeatability on the order of 1 micrometer [2]. In a second embodiment of the MEMS-tester a patterned oxide film is used to provide the initial space between the contacts. The tester will be loaded using a commercial nanoindenter to bring the surfaces into contact as contact resistance is measured as a function of the force.

REFERENCES