METAL MEMS: CREATING A NEW Class of Electrostatically Driven Devices

Chris Keimel
GE Global Research
Niskayuna, NY

Abstract*— Newly engineered micromechanical structural materials will be required to enable a novel class of MEMS devices that go beyond the signal transmission and sensing capabilities of present commercial sensors. A MEMS device capable of manipulating power requires materials with the mechanical properties near that of silicon along with the conductivity of noble metals. We have developed an electroplated nanostructured Ni-alloy that has the conductivity of nickel, a yield strength >1GPa and demonstrated its device practicality by fabricating an array of 400 switches. This 3mm by 3mm switch array, seen in Figure 1, is capable of transmitting and switching more than 1 kilowatts of power. The minimal strain rate of the nanostructured Ni-alloy makes possible cantilever switches with years of operation at elevated temperatures. The basic witching element is an electrostatically actuated cantilever beam seen in Figure 2. GEGR's metal MEMS switch technology can switch or reconfigure circuits in microseconds, isolate up to 500V across channels, provide RF isolation and low on-state losses, control more than 1kw of power, operate at temperatures in excess of 85°C and provide greater than 10 years of operational life1. The microscale switching elements make and break electrical ohmic contact in about one microsecond by controlling the relationship between the cantilevers mechanical restoring force and the drive circuitries application of an electro attractive force. Hundreds of volts are sustained across micro scale dimensions and gaps that exceed the perceived field emission limit. This sustained voltage is possible due to the gap being smaller than the mean free path of the gas molecules and thus minimizing the effect of avalanche breakdown by minimizing the ionization potential. The switch speed and high voltage capability have extended MEMS devices beyond low power sensors and actuators.

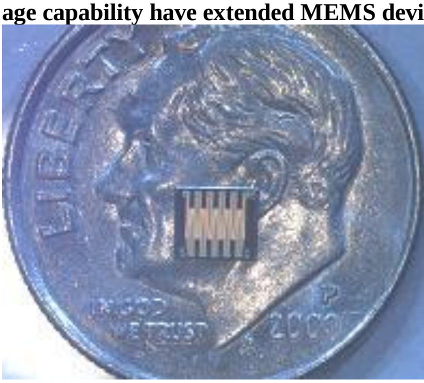

Figure 1: Top down optical image of a >1kW power MEMS switch on a dime

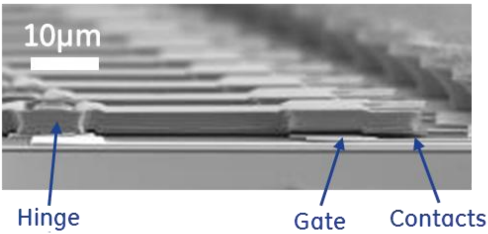

Figure 2: Side view SEM image of a GE Metal MEMS ohmic relay array of multiple parallel beams.