Finite Element Modeling of Contact Analysis of RF-MEMs Switch Membranes

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Introduction: Radio frequency (RF) micro-electro mechanical system(MEMS) switch works in on/off modes controlled by electrostatic forces. In off mode, rough surfaces of electrodes come into a contact. Membrane Contact surfaces have complex surface roughness patterns and the mechanical contact problem is very challenging to understand. The capability to predict contact quality becomes extremely important to meet the challenges in RF MEMS applications.

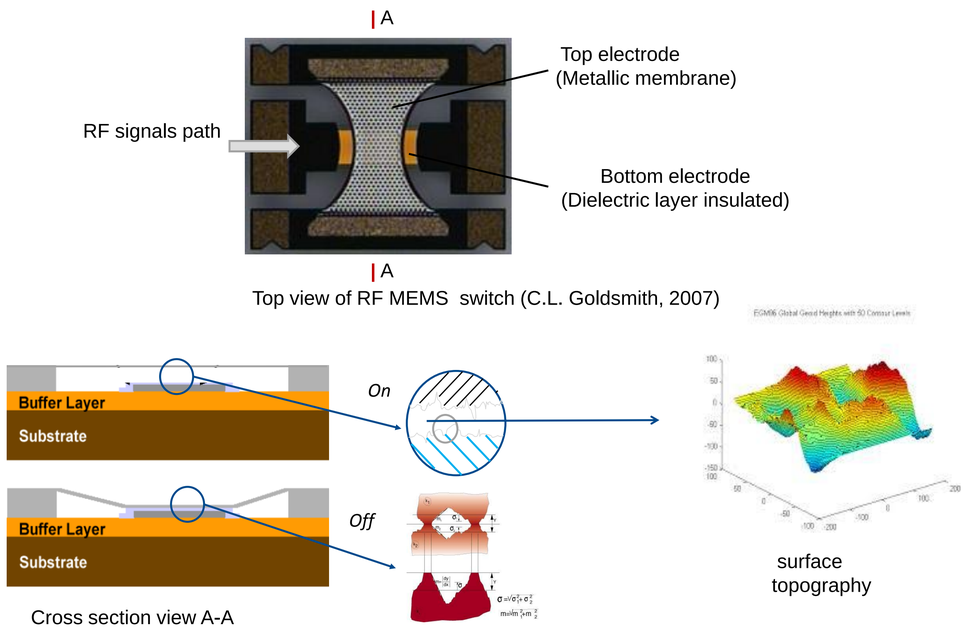

Figure 1. Top view of RF MEMS switch

Computational Methods: Atomic force microscopy (AFM) was used to record surfaces topography at three different scales,60X60 μm2,10x10 μm2 ,1x1 μm2 to acquire complete structure. Frictionless, non-adhesive contact analysis is carried out on 3 different scale models. **Nonlinear Structural Materials Module** is used for elasto-plastic contact analysis. Displacement is applied on the top of membrane to mimic the electro-static force.

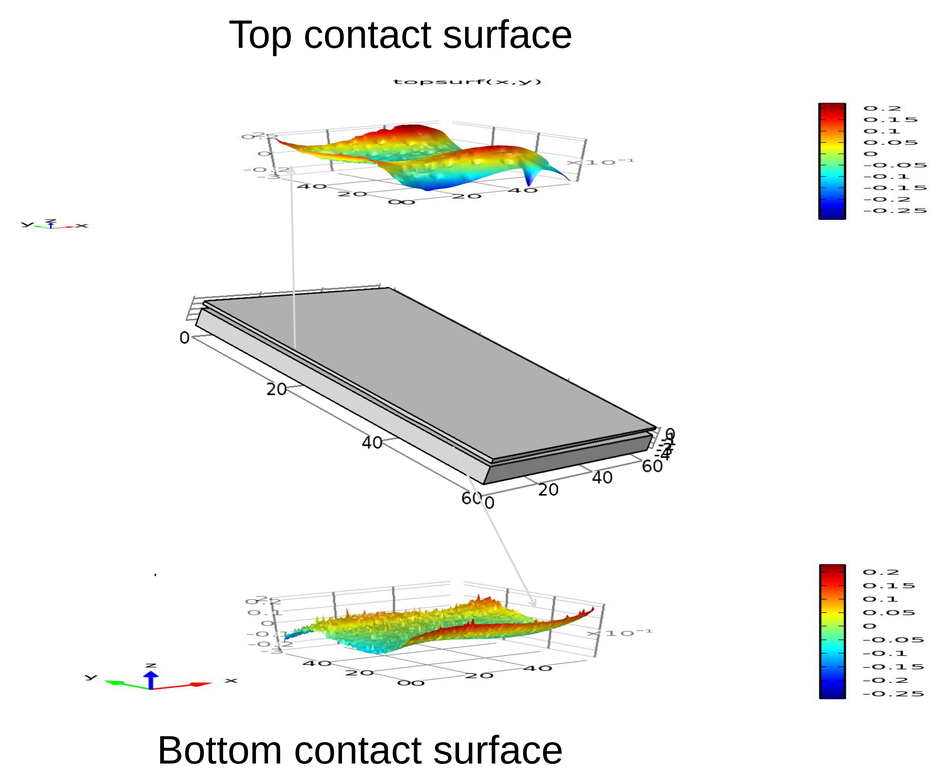

Figure 2.Contact model (60x60μm2)

Results: The dimensionless contact area rises linearly with dimensionless force at different scale models, while the slope of the linear relationship is different. Following the increase of the sample size, contact area rises faster linearly. Contact regions are mainly clustered around the regular pattern area (waviness and the large bumps). The result would imply that once the regular pattern exists in the surface structure, it will dominate the contact area.

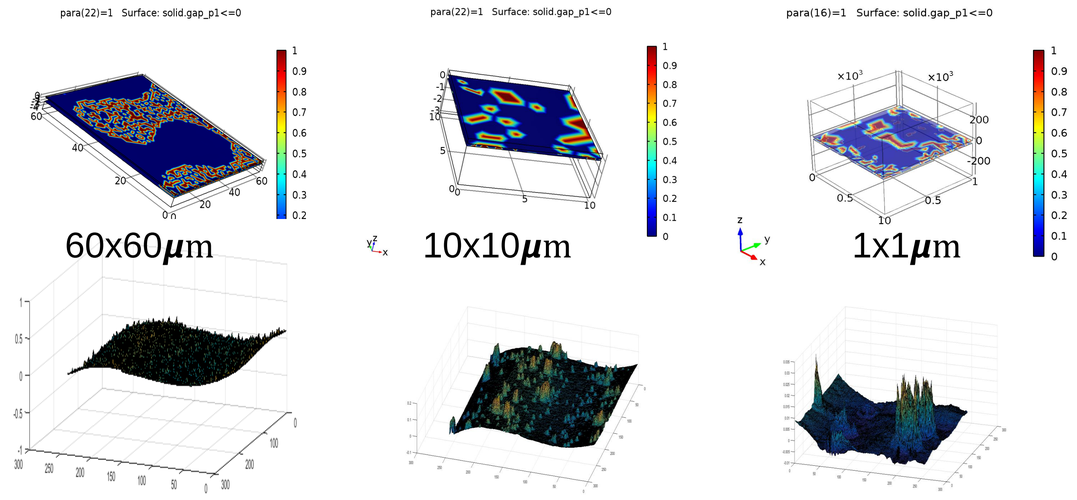

Figure 3. Contact area at different size samples

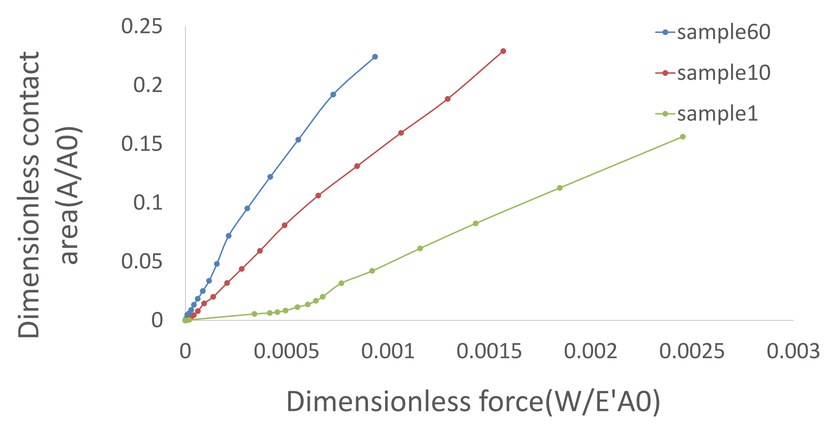

Figure 4. Linear behavior of the contact area VS. contact

Conclusions: Regular-fractal structure on MEMS surface affect contact mechanics in different scales. The work is expected to replicate and explain the way that different regular patterns and fractal irregularity affect contacts between bumps and nano-scale asperities. Contact mechanics under cyclic loading/unloading behavior which mimics the electrostatic force is a promising study in the future.

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