Finite Element Analysis of Contact Studies of Radio Frequency MEMs Switch Membranes

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Abstract

Topography of the radio frequency (RF) micro-electro-mechanical (MEM) switch surface and contact mechanics affect the reliability of the RF MEMS device. Atomic force microscopy (AFM) was used to capture the topography of the RF MEM switch contact surfaces. Multi-scale regular as well as fractal structure is observed on switch membrane surfaces. The fractal structure is spatially isotropic and statistically homogeneous at finer scales, residing on top of the regular patterns over an entire surface. Frictionless, non-adhesive contact analysis is carried out to investigate mechanical response of switch using the COMSOL Multiphysics® software. Nonlinear Structural Materials Module is implemented for elasto-plastic contact analysis on 3D RFMEM switch surfaces of different scales based on AFM topography. Multiple loading-unloading cycles is applied to mimics the on/off work status of the switch. Large clusters of contact zones part are observed around regular pattern. Contact area, contact pressure and deformation of surface structure at each loading cycle are determined as a function of applied load. The variation of contact area as well as plastic deformation of surface structure are investigated to replicate and explain the way that regular patterns and fractal irregularity affect contacts between regular bumps and nano-scale asperities. The work is expected to shed light on the quality of switch surface contact as well as optimization design of switch surface.

Reference

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Figures used in the abstract

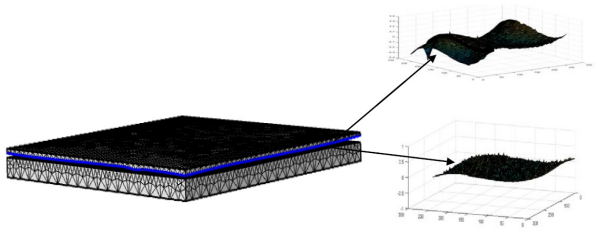

Figure 1: Mesh of sample 60*60

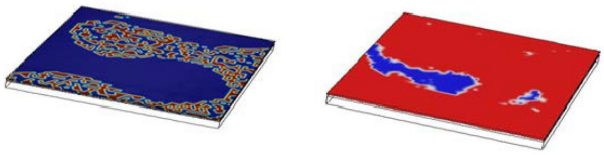

Figure 2: Contact area and plastic zone.