Statistical Modeling and Contact Analysis of RF MEMS Surface

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Abstract

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Topography of the radio frequency (RF) micro-electro-mechanical (MEM) switch surface and contact mechanics affect the reliability of the RF MEMS device. Surface topography contains complex and random features, a multi-scale sampling plan is adopted to scan the MEMS surface by atomic force microscopy (AFM) to capture the topography features from micro to nano scale. A flexible regular-fractal model was proposed to decompose and characterize surface topography. The fractal structure is spatially isotropic and statistically homogeneous in finer scales, residing on top of the regular patterns over an entire MEMS surface.
Elastoplastic contact analysis is carried out to investigate the contact status using finite element software COMSOL Multiphysics® on part of MEMS surface due to its isotropy and homogeneity. Nonlinear Structural Materials Module is adopted for structure analysis on 3D RF MEMS surface. Capability of COMSOL contact model is validated by analysis of elastic contact model of a sphere with rigid flat, comparing with Hertz model (for elastic model) and Chatterjee and Sahoo paper (for elastic-plastic model). Contact area and surface structure deformation will be obtained as functions of contact interference in multiple loading and unloading cycles to simulate the working status of RF MEMS switch. The updated topography of each loading cycle will be transit to next loading cycle to investigate the deformation of the regular and fractal structure of MEMS surface at work status.
The work is expected to shed light on the quality of MEMS surface contact and optimization design of switch surface.

Reference

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Figures used in the abstract

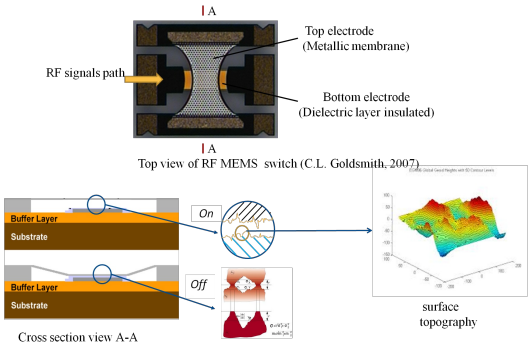

Figure 1: View of RF MEMS switch

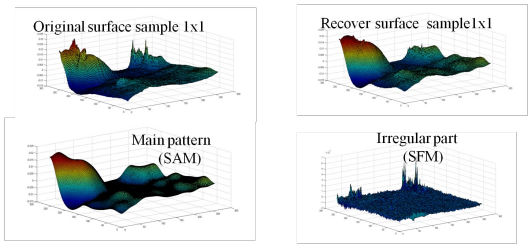

Figure 2: Contact Model of 62.5x62.5 nm^2

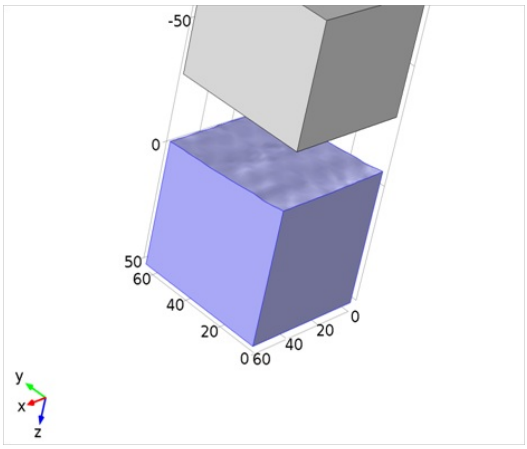

Figure 3: Surface Topography Simulation and Comparision (1x1

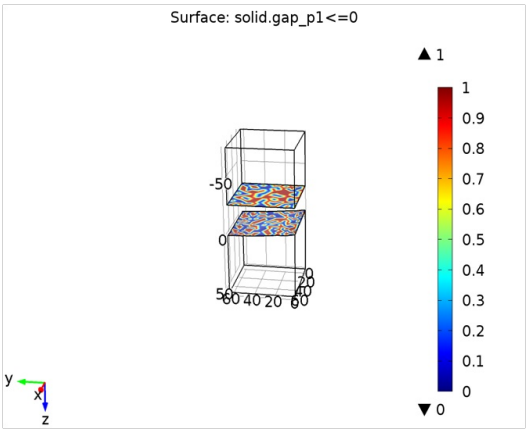

Figure 4: Interference 30nm, Contact area(m^2): 1.92e-15 Total area(m^2): 3.9e-15