## A stochastic multiscale analysis for MEMS stiction failure

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Stiction is a major failure in microelectromechanical system (MEMS) devices in which two contacting surfaces can remain stuck together because of the adhesive forces, such as van der Waals forces and capillary forces. Stiction is a multiscale problem which is characterized by three different lengths: the MEMS device characteristic length, the roughness of the contacting surfaces, and the distance range of the adhesive forces. Because MEMS surfaces roughness and adhesive force distances are of comparable scales, the randomness in the contacting surfaces can result in important uncertainties on the interacting forces, and in turn lead to a scatter in the MEMS structural behavior.

The purpose of this work is to quantify the uncertainties on the macro stiction behavior of a MEMS structure due to the randomness in its contacting surfaces. A full analysis, such as the combination of a Monte-Carlo simulation to generate random surfaces combined with finite element (FE) analyses to model the stiction behavior, is expensive in terms of the computational cost due to the difference in the scales between the macro characteristic length and the distance range of the adhesive forces. Thus, in this work, we develop a stochastic multiscale analysis.

At the micro scale, the uncertainties in the interacting forces between two rough surfaces are investigated. The power spectral density function of the surface is characterized from experimental topology measurements, and interacting surfaces are then generated as Gaussian random surfaces. For each generated random surface, the interacting adhesive forces are calculated by using a modified Dejarguin-Muller-Toporov (DMT) model. The resulting adhesive contact forces can be integrated using the finite element method at the structural scale by associating to each discretized contacting point a sampled surface. We then use the Monte-Carlo method to quantify the uncertainties in the stiction behavior of the MEMS device.

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