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Casimir forces in MEMS/NEMS: influence of nanoscale surface roughness and material optical properties

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Understanding the vacuum state of a quantum system is one of the major challenges of fundamental physics and some associated increasingly important technologies. It is also a key to model the possible origin of our universe and its observed accelerated expansion. If confined within boundaries, vacuum fluctuations manifest themselves by the generation of Casimir forces. However, boundaries between interacting bodies possess in many cases, nanoscale surface roughness, which is both difficult to avoid and control. When two bodies are separated by a small distance (e.g., less than 200 nm) the roughness starts to play an important role on the Casimir interaction between the bodies and their adhesion. Control of this short-distance interaction is crucial for micro and nanoelectromechanical devices, microfluidics, and for micro/nanotechnology. These forces between flat bodies can be described by the Lifshitz theory that takes into account the actual measured optical properties of interacting materials. For rough surfaces the problem is complicated by the non-additive nature of the dispersion forces. In this talk I will review the current state of the problem with attention to metallic systems, phase change materials, and pure conductors (promising for devices operating under severe environments) with respect to actuation dynamics of MEMS/NEMS.

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