Abstract

The lateral Casimir force, which arises between aligned sinusoidally corrugated surfaces of a sphere and a plate, was measured for the case of a small corrugation period beyond the applicability region of the proximity force approximation. The increased amplitudes of the corrugations on both the sphere and the plate allowed observation of an asymmetry of the lateral Casimir force, i.e., deviation of its profile from a perfect sine function. The dependences of the lateral force on the phase shift between the corrugations on both test bodies were measured at different separations in two sets of measurements with different amplitudes of corrugations on the sphere. The maximum magnitude of the lateral force as a function of separation was also measured in two successive experiments. All measurement data were compared with the theoretical approach using the proximity force approximation and with the exact theory based on Rayleigh expansions with no fitting parameters. In both cases real material properties of the test bodies and nonzero temperature were taken into account. The data were found to be in a good agreement with the exact theory but deviate significantly from the predictions of the proximity force approximation approach. This provides the quantitative confirmation for the observation of diffraction-type effects that are disregarded within the PFA approach. Possible applications of the phenomenon of the lateral Casimir force in nanotechnology for the operation of micromachines are discussed.

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