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Temperature Dependence of the Casimir Force between Silicon Slabs

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The Casimir forces between semi-infinite silicon slabs at 30 and 510 K are calculated by using analytical expressions of the complex dielectric functions of Si, $\varepsilon(\omega)=\varepsilon_1(\omega)+i\,\varepsilon_2(\omega)$ described by Aoki and Adachi, which are in satisfactory agreement with the experimental information over the entire range of photon energies. The temperature dependence of the Casimir force on the transition of ε_2 and that on the black body radiation at finite temperature are evaluated respectively. It is shown that the primary factor of the temperature dependence for separations smaller than 1 μm is the transition of ε_2, and the contribution of the black radiation increases for larger separations. The strength relation between the Casimir force at 30 K and that at 510 K is reversed at a threshold near 45 nm along with the increment of the separation. This transition is discussed by examining the Casimir force between materials of which ε_2 is characterized by a rectangle function.

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