On the force between two metallic plates of a gripper immersed in a nonpolar fluid

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Abstract

In the current article, we study the force between two metallic plates of a gripper immersed in nonpolar fluid. We analyse, as a function on the temperature *T* and the chemical potential *μ*, the total force $F_{tot}(T,\mu,L)$ between the two metallic plates of a gripper separated at a distance *L* from each other and immersed in a nonpolar fluid, which can be liquid, or gas. In our approach, we take into account:

- the direct substrate-substrate van der Waals interaction;
- the van der Waals interactions between the molecules of the fluid with the other molecules of the fluid as well as with the constituent elements of the substrate, and
- the interaction between the plates generated by the fluctuations of the density of the fluid (i.e., the Casimir force).

We suppose that both plates are equal and strongly prefer the liquid phase of the fluid. Under such boundary conditions both the direct plate-plate van der Waals interaction, as well as the Casimir force, are forces of attraction of the plates toward each other.

In the phase space (temperature, chemical potential), we identify the regions where the net interaction force is the strongest. It turns out that these regions are close to the bulk critical point of the fluid $(T=T_c,\mu=\mu_c)$, and near the so-called capillary condensation regime $T<T_c,(L/a)(\Delta\mu/k_BT)=O(1)$, with $\Delta\mu=\mu-\mu_c<0$ and a the characteristic distance between the molecules of the fluid.

These regions shall be avoided in order to prevent sticking of the plates of the gripper on each other.

In the current article, we present a model and on its basis do study the force acting between the two metallic plates of a gripper immersed in a nonpolar fluid. This force shall be taken into account when one designs the control and management of the plates of a gripper that is supposed to perform a given operation in a concrete type of fluid.