Analytic expressions for the disjoining pressure between particle-stabilized fluid–fluid interfaces and composite materials

C. Vannozzi*

Dpt. Chemical Engineering, University of California Santa Barbara, USA
* e-mail: carolina.vannozzi@gmail.com

A general method based on a hybrid Hamaker-Lifshitz approach is described in order to calculate the disjoining pressure (i.e. van der Walls forces per unit area) of thin films between two drops having Janus nanoparticles at their interfaces [1]. The drops are modeled here as half spaces and the spherical particles are arranged in 2D-lattices straddling the interfaces (see figure 1). Analytical expressions are derived to consider the effects of particle concentration, size, core material and relative position of the facing lattices on the disjoining pressure. Knowledge of the dependence of the disjoining pressure on these quantities is necessary to determine the ability of the nanoparticles to stabilize immiscible polymer blends against coalescence, thus in the design of effective nanoparticles stabilizers. The method is also applied to the case of two compound half spaces of polymers with 3D lattices of spheres dispersed in it interacting across a medium. This system is considered as a model for drops with particles dispersed in their bulk or for interacting colloidal/nanocrystals and as a test case to validate our method against well known effective medium expressions. Our method, whose main applicability is polymeric materials or materials without strong dipole moments, is promising for its ability to deal with complex geometries and with the presence of an intervening medium in a simple way, thus leading to analytical expressions that can be used both in experiments and in numerical simulation studies.

Figure Sketch of the model systems. (a) Section representing two infinite compound half spaces of material 1, with spherical inclusions of material 2 straddling its interfaces, interacting across medium 3. The particles are arranged in a 2D-simple cubic lattice, with lattice constant a, and the two interfaces at distance D apart; (b) The same system as in (a), with particles dispersed in a 3D-simple cubic lattice of spherical particles in the bulk of medium 1.