SUPPORTING INFORMATION

Contributions of Nanoscale Roughness to Anomalous Colloid Retention and Stability Behavior

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Supporting Information

The supporting information contains details pertaining to interactions energy calculations (S1). Figure S1 presents a plot of ε_1 as a function of Φ_{max} when Φ_{2min}=0 and Φ_{1min}=-∞ (unfavorable electrostatic conditions), and ε_{r1} as a function of Φ_{1min} when Φ_{2min}=0 and Φ_{max}=0 (favorable electrostatic conditions). Figure S2 presents plots of Φ_{1min} for a physically and chemically homogeneous oocyst and SWI when the IS=10 mM and the zeta potential of the oocyst and the SWI were varied between -60 to 60 mV. This information is available free of charge via the Internet at http://pubs.acs.org

S1 – Interaction Energy Calculations

The value of Φ_s between a colloid and the SWI, or another colloid, was considered to be the sum of electrostatic, van der Waals, and Born repulsion interaction energies:

$$\Phi_S(h) = \Phi_s^{el}(h) + \Phi_s^{vdW}(h) + \Phi_s^{Born}(h) \qquad \text{[S1]}$$

where Φ_s^{el} [ML^2T^{-2}], Φ_s^{vdW} [ML^2T^{-2}], and Φ_s^{Born} [ML^2T^{-2}] are the electrostatic, van der Waals, and Born interaction energies on the smooth surface, respectively. The value of Φ_s^{el} was determined using the constant surface potential interaction expression of Hogg et al.[1] for a sphere-plate interaction as:

$$\Phi_s^{el}(h) = \pi\varepsilon\varepsilon_0 r_c \left\{2\zeta_1\zeta_2 ln\left[\frac{1+\exp(-\kappa h)}{1-\exp(-\kappa h)}\right] + (\zeta_1^2+\zeta_2^2) ln[1-\exp(-2\kappa h)]\right\} \qquad \text{[S2]}$$

where ε (dimensionless) is the dielectric constant of the medium, ε_0 [$M^{-1}L^{-3}T^4A^{-2}$, where A denotes ampere] is the permittivity in a vacuum, r_c [L] is the colloid radius, ζ_1 is the zeta potential of the colloid, ζ_2 is the zeta potential of the collector, and κ [L^{-1}] is the Debye-Huckel parameter. The value of Φ_s^{vdW} for a sphere-plate interaction was determined using the expression by Gregory[2] as:

$$\Phi_s^{vdW}(h) = -\frac{A_{123} r_c}{6h}\left[1 + \frac{14h}{\lambda}\right]^{-1} \qquad [S3]$$

where A_{123} [ML^2T^{-2} is the Hamaker constant, and λ is a characteristic wavelength that was taken as 100 nm.[2] The value of Φ_s^{Born} was calculated from Ruckenstein and Prieve[3] for a sphere-plate interactions as:

$$\Phi_s^{Born}(h) = \frac{A_{123}\sigma_c^6}{7560}\left[\frac{8r_c+h}{(2r_c+7)^7} + \frac{6r_c-h}{h^7}\right] \qquad [S4]$$

The collision diameter,σ_c, was taken as 0.26 nm in order to achieve a primary minimum depth at 0.157 nm, a commonly accepted distance of closest approach.[4]

Slightly modified versions of Eqs. [S2] and [S3] were employed for colloid-colloid interactions. In particular, the value of r_c was replaced by $r_{c1}r_{c2}/(r_{c1}+r_{c2})$ for sphere-sphere interactions; where r_{c1} [L] and r_{c2} [L] are the radii of two colloids denoted with subscripts 1 and 2, respectively. Unfortunately, Eq. [S4] cannot be simply modified in a similar manner to determine the Born repulsion for sphere-sphere geometry. In this case, the expression of Oliveira[5] was employed to determine Born repulsion as:

$$\Phi_s^{Born}(h) = \frac{A_{123}H_{min}^6}{168h^7}\left[\frac{r_{c1}r_{c2}}{r_{c1}+r_{c2}}\right] \qquad [S5]$$

where H_{min} [L] is the value of closest approach equal to 0.157 nm.

All interaction energies were made dimensionless by dividing by the product of the Boltzmann constant ($k_B = 1.38\times10^{-23}$ J K^{-1}) and the absolute temperature (T_K).

Cited Literature

(S1) Hogg, R.; Healy, T. W.; Fuerstenau, D. W., Mutual coagulation of colloidal dispersions. *Trans. Faraday Soc.* **1966**, 62, 1638−1651

(S2) Gregory, J., Approximate expression for retarded van der Waals interaction. *J. Colloid Interface Sci.* **1981**, 83, 138–145.

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(S4) van Oss, C.J. *Interfacial Forces in Aqueous Media*. Marcel Dekker (New York), **1994**.

(S5) Oliveira, R. Understanding adhesion: a means for preventing fouling. *Exp. Therm. Fluid Sci.* **1997**, 14, 316–322.

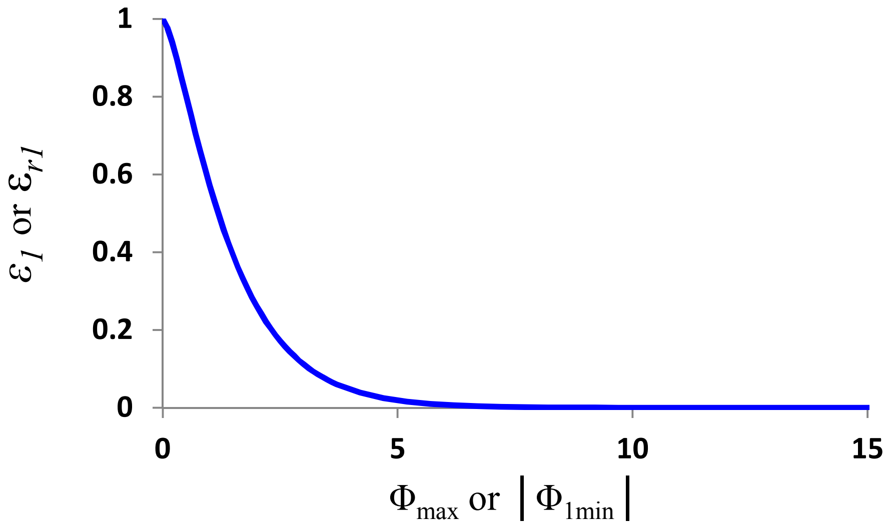

Figure S1. Plots of ε_1 as a function of Φ_{max} when Φ_{2min}=0 and Φ_{1min}=-∞ (unfavorable electrostatic conditions), and ε_{r1} as a function of the magnitude of Φ_{1min} when Φ_{2min}=0 and Φ_{max}=0 (favorable electrostatic conditions).

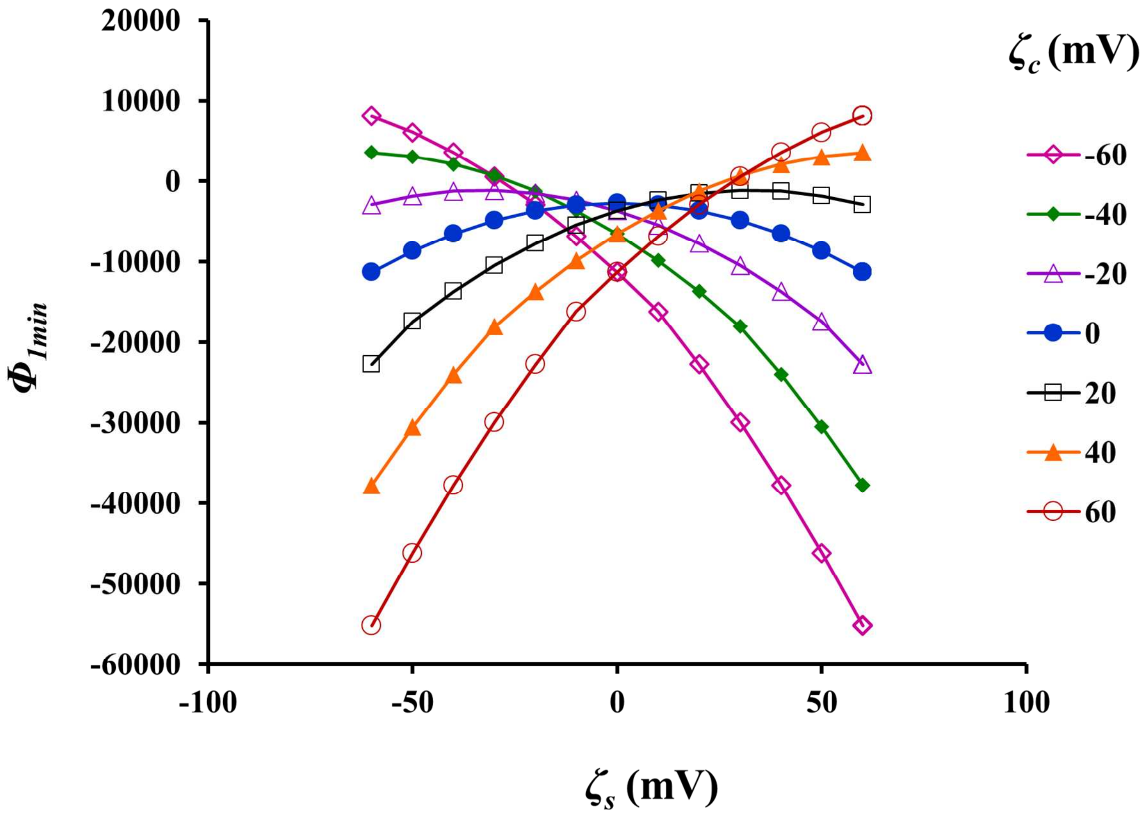

Figure S2. Plots of Φ_{1min} for a physically and chemically homogeneous oocyst and SWI when the IS=10 mM and the zeta potential of the oocyst and the SWI were varied between -60 to 60 mV.