Supporting Information

Kinetics of Coupled Primary- and Secondary-Minimum Deposition of Colloids under Unfavorable Chemical Conditions

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Number of pages: 3

Number of figures: 1

Number of tables: 1

Supporting Information

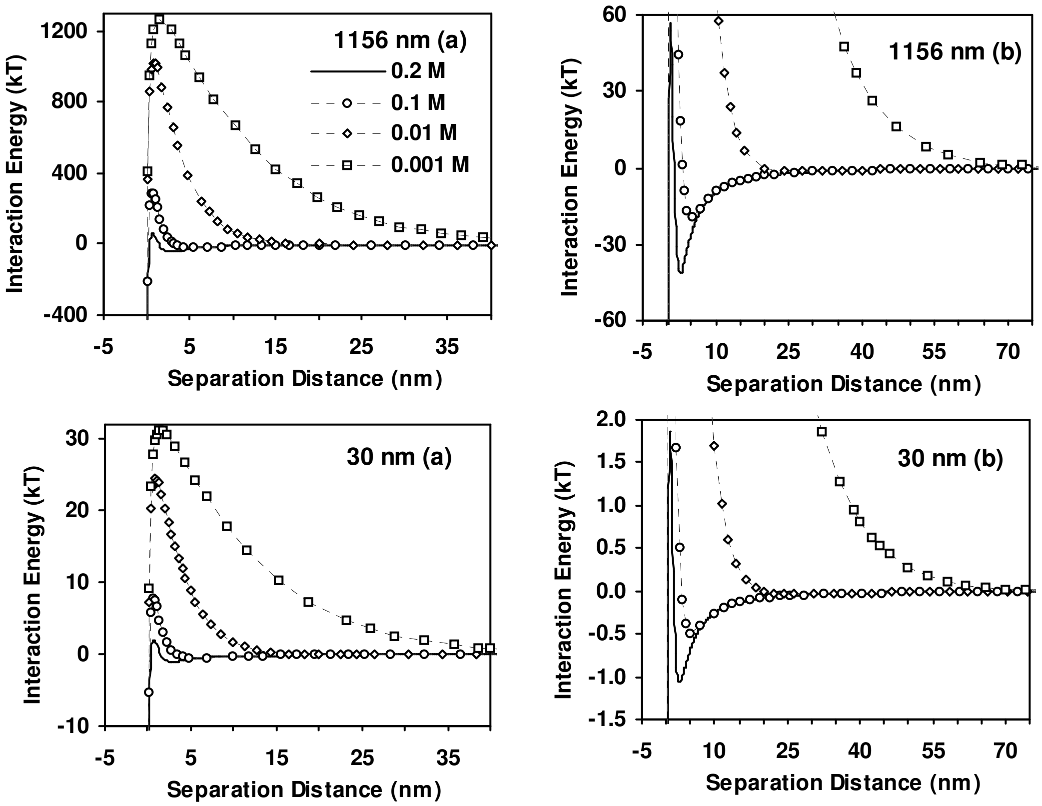

Fig.S1 DLVO energy profiles for the 1156 nm and 30 nm colloids (A=1×10^{-20} J, T=298 K). (a) Calculated interaction energy as a function of separation distance at different ionic strengths; (b) Re-plotted profiles to highlight the depth and location of secondary minimum.

Table S1. Zeta potentials of sand and colloids (1156 nm and 30 nm), and calculated maximum energy barriers (Φ_{max}), secondary-minimum (Φ_{sec}) depths and distances for both colloids at different ionic strengths.

I (M)	Zeta Potential (mV)			Φ_{max} (*kT*)		Φ_{sec} Depth (*kT*)		Φ_{sec} Distance (nm)	
	Sand	**1156 nm**	30 nm	**1156 nm**	30 nm	**1156 nm**	30 nm	**1156 nm**	30 nm
0.001	-39.27	-46.73	-44.3	1267.70	31.31	0.11	0.003	110.13	109.46
0.01	-39.13	-46.46	-43.25	1019.47	24.41	1.54	0.04	26.03	25.71
0.1	-32.08	-38.04	-38.69	291.80	7.83	19.60	0.51	5.12	5.15
0.2	-27.49	-35.21	-36.86	59.94	1.97	41.30	1.05	2.81	2.87

Maxwell Model

The velocity distribution of the colloids in the secondary minimum follows the function:

$$f(v) = 4\pi \left(\frac{m_p}{2\pi kT} \right)^{(3/2)} v^2 \exp\left(-\frac{m_p v^2}{2kT} \right) \qquad (1)$$

where

$$\int_0^\infty f(v)dv = 1 \qquad (2)$$

and m_p is mass of a colloid and v is its velocity. Here a dimensionless kinetic energy of the colloid is defined as

$$x^2 = \frac{m_p v^2}{2kT} \qquad (3)$$

Then equation (1) simplifies to

$$f(v) = 4x^2 \exp(-x^2) \sqrt{\frac{m_p}{2\pi kT}} \qquad (4)$$

According to assumption (ii), the fraction of successful collisions (arrival at the separation distance corresponding to the secondary minimum) that result in deposition in the secondary minimum, α_{sec}, is given by

$$\alpha_{\sec} = \int_0^{v_{\sec}} f(v)dv = \int_0^{v_{\sec}} 4x^2 \exp(-x^2) \sqrt{\frac{m_p}{2\pi kT}} dv = \int_0^{\sqrt{\Phi_{\sec}}} \frac{4}{\pi^{1/2}} x^2 \exp(-x^2) dx \qquad (5)$$

where $\Phi_{\sec} = mv_{sec}^2/2kT$. Similarly, the fraction of successful collisions resulting in colloid deposition in the primary minimum, α_{pri}, is

$$\alpha_{pri} = \int_{\sqrt{\Delta\Phi}}^\infty \frac{4}{\pi^{1/2}} x^2 \exp(-x^2) dx \qquad (6)$$

The total fraction of successful collisions α (sum of α_{sec} and α_{pri}) is written as

$$\alpha = \alpha_{pri} + \alpha_{\sec} = 1 - \int_{\sqrt{\Phi_{\sec}}}^{\sqrt{\Delta\Phi}} \frac{4}{\pi^{1/2}} x^2 \exp(-x^2) dx \qquad (7)$$