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Transport of nanoparticles in a temperature gradient SHAWN PUTNAM, DAVID CAHILL, Center of Advanced Materials for the Purification of Water with Systems, Univ. of Illinois — Thermodiffusion, mass transport in a temperature gradient, is commonly characterized by either the thermodiffusion coefficient D_T or the Soret coefficient S_T; e.g., at low particle concentration c, the particle flux of a colloidal suspension subjected to a temperature gradient ∇T is $\mathbf{J} = -cD_T\nabla T - D_c\nabla c$, where D_c is the diffusion coefficient and the Soret coefficient is $S_T = D_T/D_c$. We present our measured D_T data for aqueous suspensions of charged polystyrene spheres, alumina nanoparticles, and globular proteins of lysozyme. Special emphasis is given to our published work on charged polystyrene spheres with different surface functionalities. For example, in solutions with large concentrations of monovalent salts, $\gtrsim$ 100 mM, D_T for 26 nm spheres with carboxyl functionality can be varied within the range -0.9×10^{-7} cm^2 s^{-1} K^{-1} $< D_T <$ 1.5×10^{-7} cm^2 s^{-1} K^{-1} by changing the ionic species in solution; in this case D_T is the product of the electrophoretic mobility μ_E and the Seebeck coefficient of the electrolyte $S_e = (Q^*_{\rm C} - Q^*_{\rm A})/2eT$, $D_T = -S_e\ \mu_E$, where $Q^*_{\rm C}$ and $Q^*_{\rm A}$ are the single ion heats of transport of the cationic and anionic species respectively. On the contrary, in low ionic strength solutions of LiCl, $\lesssim$ 5 mM, D_T for the 26nm carboxyl spheres is negative, independent of particle concentration, and independent of the Debye length; $D_T = -0.73 \pm 0.05 \times 10^{-7}$ cm^2 s^{-1} K^{-1}. The temperature dependence of D_T is also discussed with results from our current work with polystyrene spheres, alumina nanoparticles, and protein solutions of lysozyme.

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