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Electrophoretic Mobility of a Polymer-coated Colloidal Particle in a Salt-free Medium

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Abstract — A theory is presented for the electrophoretic mobility (μ) of dilute spherical colloidal particles covered with an ion-penetrable uncharged polymer layer in a salt-free medium containing only counterions. It is shown that as in the case of other types of colloidal particles such as rigid particles and charged-polymer coated particles, there is a certain critical value of the particle charge (Q) separating two cases : the low-charge case and the high-charge case. For the low-charge case, μ is given by $\mu = Q/D_H$, where D_H is the drag coefficient of the particle. The electrophoretic mobility in the low-charge case coincides with that of a polymer-coated particle in an electrolyte solution in the limit of very low electrolyte concentrations (Hückel's limit). For the high-charge case, μ becomes constant independent of Q due to the counterion condensation effects. Expressions for the electrical conductivity and the sedimentation potential are also obtained. An Onsager relation is found to hold between electrophoretic mobility and sedimentation potential.