427f Mobile-Surface-Charge Model for the Accurate Prediction of Cell Surface Charge from Electrophoretic Mobility Data

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The measurement of cell electrophoretic mobility (EPM), the ratio of velocity to electric field strength, is often used to estimate the total surface charge of a cell. However, comparison of surface charges calculated from EPM values with recent colloid titration measurements shows that the most widely used EPM model dramatically underestimates surface charge. For example, bovine aortic endothelial cells have a chemically-determined surface charge of 1.07 coulomb/m^2, while a calculation from EPM data using the often-cited Smoluchowski formula predicts only 9.38×10^{-3} coulomb/m^2. A new model that incorporates the effects of cellular size and electric field strength to accurately predict surface charges from electrophoretic mobility has been developed. Previous models have predicted that electrophoretic mobility (EPM) is dependent only on cell surface charge, bath viscosity and ionic strength of the electrolyte. The new model accounts for electrically-driven redistribution of mobile surface charge islands, such as the recently proposed “lipid raft” structures. This model adjusts surface charge predictions based on a new dimensionless quantity that balances the cell radius, the electric field strength, and the average diameter of charged membrane complexes. Predicted values correlate well with colloid titration data from the literature for four distinct cell types.