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Numerical and experimental study of dispersion dynamics in isotachophoresis GIANCARLO GARCIA, MORAN BERCOVICI, JUAN G. SANTIAGO, Stanford University — Isotachophoresis (ITP) is a separation and preconcentration technique used in a variety of life science and analytical chemistry applications. Under ideal ITP conditions, sample ions focus in a narrow interface region (1-10 μm) between leading and terminating electrolytes. In practice, however, the associated electric field gradients at this interface give rise to non-uniform electroosmotic flow (EOF) and associated strong internal pressure gradients. Conductivity gradients also couple with electric fields to yield electrohydrodynamic body forces. Together, these forces disperse the ITP interface and reduce the sensitivity and resolution of ITP-based assays. Despite its importance in ITP, there has been surprisingly little research into the underlying physical mechanisms of dispersion. We performed a numerical and experimental study of dispersion dynamics in ITP using two-dimensional (axi-symmetric), time-dependent simulations of fluid flow, diffusion, and electromigration. We validated our models with controlled experiments in circular capillaries and used simulations to develop general scaling relationships. We observe localized focusing of the analyte in either near-axis or near-wall regions; and the degree to which these conditions are favored is a strong function of the axial location of the ITP interface. Our goal is to develop an area-averaged model for rapid prediction of the effects of EOF in experiments.

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