

Polymer and Colloid Highlights

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Towards Ångström Resolution with Dynamic Light Scattering

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Dynamic light scattering (DLS) or so-called photon correlation spectroscopy enables us to measure diffusion coefficients (or equivalently hydrodynamic radii) in polymer solutions or colloidal particle suspensions. Since its invention in the sixties, DLS has evolved into an indispensable tool of every modern laboratory dealing with macromolecules, surfactants, or nanoparticles.

A popular application of DLS is the measurement of the layer thickness L of an adsorbed polymer layer. The thickness is estimated from the difference between the hydrodynamic radii of colloidal particles with and without adsorbed polymer (Fig. 1, top). Early experiments following this strategy were plagued by poor sensitivities of the available instruments, and the necessity to work at too high particle concentrations where effects of particle–particle interactions and aggregation are unavoidable.

Recent developments in DLS instrumentation including back-scattering and simultaneous multi-angle techniques now permit measurements with much higher sensitivities and consequently at substantially lower particle concentrations.

With these modern developments, the hydrodynamic layer thickness of adsorbed polyelectrolytes on oppositely charged particles can be measured. Based on theoretical arguments, it was suspected that such layers are extremely thin, and that their thickness increases with the salt level.^[1] However, an experimental proof was lacking. With simultaneous multi-angle DLS (Fig. 1, bottom right) we are able to measure the thickness of such adsorbed layers with a precision of better than 3 Ångströms.^[2] Typical results for cationic linear poly(ethylene imine) adsorbed on sulfate latex particles as a function of the ionic strength are shown in Fig. 1 (bottom left). Indeed, the thickness is mere 20 Å at low salt levels. However, at higher salt levels it raises abruptly to about 65 Å. The nature of this transition is probably related to screening of the electrostatic attractions between the polyelectrolyte chains and the substrate.

We expect this novel high-resolution DLS technique to be useful to study a wide variety of adsorbed layers, including those of surfactants or biomacromolecules.

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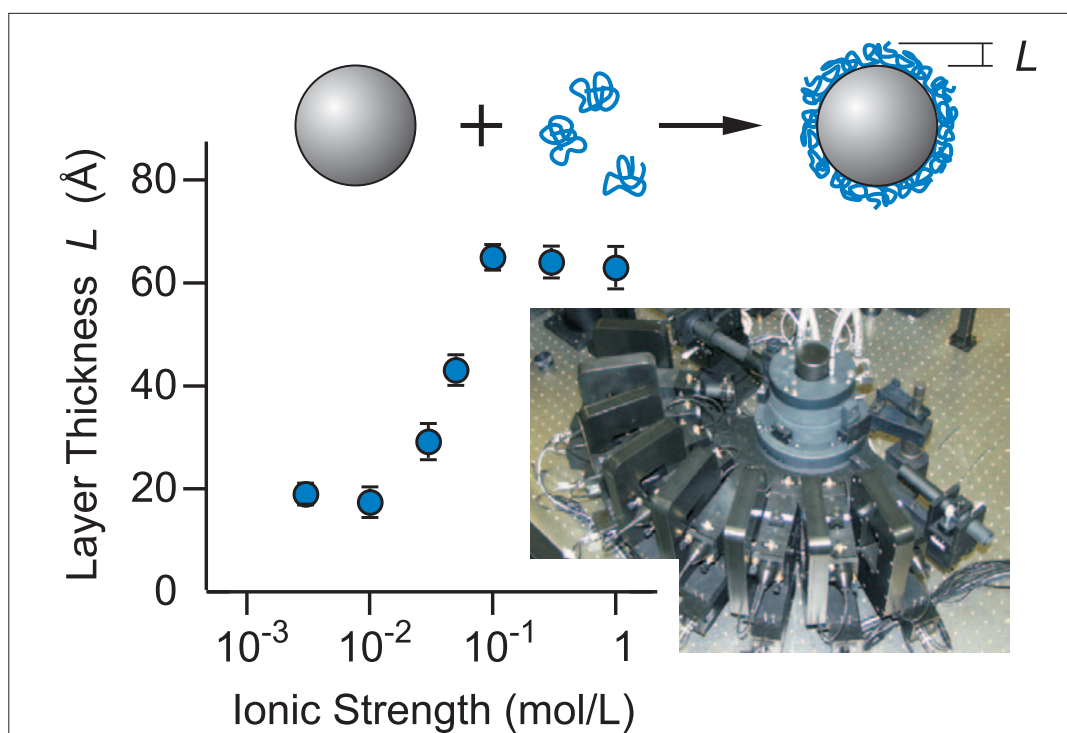


Fig. 1. Principle of the hydrodynamic layer thickness measurement by DLS (top). Picture of the multi-angle goniometer to perform these measurements (right) is shown together with experimental data for adsorbed polyelectrolytes on oppositely charged particles.