

SYPE 3: Polyelectrolytes II

Time: Friday 10:30–12:30

Location: H1

Invited Talk

SYPE 3.1 Fri 10:30 H1

Behaviour of polyelectrolyte solutions under confinement — ●DOMINIQUE LANGEVIN¹, CÉSAR MARQUEZ², HEINIG PETER³, and DAN QU⁴ — ¹Laboratoire de Physique des Solides, Université Paris-Sud, Batiment 510, 91405 Orsay — ²Laboratoire de Physique des Solides, Université Paris-Sud, Batiment 510, 91405 Orsay — ³Laboratoire de Physique des Solides, Université Paris-Sud, Batiment 510, 91405 Orsay — ⁴Laboratoire de Physique des Solides, Université Paris-Sud, Batiment 510, 91405 Orsay

We have studied free horizontal liquid films made with semidilute polyelectrolyte solutions and stabilised by minute amounts of surfactants. A stratification phenomenon is observed during film thinning, with a step size close to the mesh size of the polymer network: dark domains nucleate and expand, the outer polymer layer dewetting a thinner film. The kinetics of dark spot expansion is not simply related to bulk viscosity and becomes slower or faster when the film thickness decreases, depending of the surface conditions (presence or absence of a mixed polyelectrolyte surfactant surface layer). Other domain shape dynamics have been analysed and related to a local viscosity in stratifying foam films.

SYPE 3.2 Fri 11:00 H1

Polyelectrolyte complexes and effective charge — UTE BÖHME BÖHME and ●ULRICH SCHELER — Leibniz-Institut für Polymerforschung Dresden, e.V., Hohe Str. 6, D-01069 Dresden

Condensation of counterions onto polyelectrolytes is directly monitored in diffusion and electrophoresis NMR. From a combination of both experiments the effective charge per molecule is determined. The diffusion coefficient and electrophoretic mobility measured for counterions or small ligands is the population-weighted average of the values for the free and the bound state, the later corresponding to that of the polymer. Knowing both values, the bound fraction of counterions is calculated, from which with the effective charge the molecular weight of the polymer is determined model free. Binding of ligands and the formation of polyelectrolyte complexes is investigated with an emphasis on weak binding and the equilibrium states. Examples shown include flexible polyelectrolyte like PDADMAC and PSS and rigid-rod poly(aramides).

SYPE 3.3 Fri 11:15 H1

A new method to determine ionic mobilities in polymer electrolytes at low charge carrier density — ●PETER KOHN, KLAUS SCHÖTER, and THOMAS THURN-ALBRECHT — Department of Physics, Martin Luther University Halle-Wittenberg, Germany

Apart from mechanical properties the conductivity and its dependence on various parameters like temperature, number of charge carriers, etc., is the decisive quantity for applications of ionically conducting materials. As for other conducting systems the conductivity is determined by the product of the mobility and the number density of the free charge carriers. A basic understanding therefore requires the knowledge of at least one of these quantities in addition to the conductivity.

We present an electrical method that allows an independent determination of the charge carrier density and the mobility of the ions in polymer electrolytes with low density of charge carriers. The number density of free ions is obtained by polarization experiments with high DC-voltages and the ion-mobility can be determined from the transient current after a subsequent voltage reversal.

For an exemplary application we studied polymethylmethacrylate (PMMA) doped with small amounts of a lithium salt (LiCF₃SO₃). A comparison of the values obtained for the ion mobility and the charge carrier density with the conductivity shows good agreement for all salt concentrations studied.

Invited Talk

SYPE 3.4 Fri 11:30 H1

Polymers at Surfaces: Sticking and Gliding — ●ROLAND NETZ

— Physics Department, TU Munich, 85748 Garching, Germany

Recently, peptides and different polyelectrolytes were pulled off from various low-dielectric and high-dielectric surfaces with the AFM, leading to a number of interesting observations: i) Surprisingly, the electrostatic contribution to the adsorption energy is always quite small, even for highly charged surfaces. The dominant solvation attraction can be quantitatively explained with classical MD simulations including explicit water. ii) Charge regulation of polymers at the surfaces is important and has to be taken into account for the quantitative modeling of adsorption energies. iii) Uncharged, hydrophobic surfaces appear negatively charged and give rise to sizable electrostatic adsorption energies. This finding is related to the water structure at hydrophobic substrates which involves an oriented first water layer and specific ion adsorption. iv) The friction coefficient of bound polymers is very low on hydrophobic substrates, which is traced back to the presence of a vacuum layer between substrate and water, which forms a lubricating cushion on which the polymers glide.

SYPE 3.5 Fri 12:00 H1

The force on DNA in a nanopore — ●U. F. KEYSER^{1,2}, S. VAN DORP¹, R. M. M. SMEETS¹, D. KRAPP¹, N. H. DEKKER¹, and C. DEKKER¹ — ¹Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands — ²Institut für Experimentelle Physik I, Universität Leipzig, Germany

Among the variety of roles for nanopores in biology, an important one is enabling transport of polyelectrolytes like DNA or RNA, for example in gene transfer between bacteria and transport of RNA through the nuclear membrane. Recently, this has inspired the use of protein and solid-state nanopores as single-molecule sensors for the detection and structural analysis of DNA and RNA by voltage-driven translocation [1]. The magnitude of the force involved is of fundamental importance in understanding and exploiting this translocation mechanism, yet so far it has remained unknown. Here, we demonstrate the first measurements of the force on a single DNA molecule in a solid-state nanopore by combining optical tweezers with ionic-current detection [2]. The opposing force exerted by the optical tweezers can be used to slow down and even arrest the translocation of the DNA molecules [3]. We obtain a value of 0.24 ± 0.02 pN mV⁻¹ for the force on a single DNA molecule, independent of salt concentration from 0.02 to 1M KCl. [1] R. M. M. Smeets, U. F. Keyser, et al. Nano Letters 6 (2006) [2] U. F. Keyser et al., Rev. Sci. Instr. 77, 105105 (2006) [3] U. F. Keyser et al., Nature Physics 2, 473 (2006)

SYPE 3.6 Fri 12:15 H1

Forces of interaction between DNA-grafted colloids: an optical tweezers measurement — ●FRIEDRICH KREMER¹, KATI KEGLER¹, CHRISTOF GUTSCHE¹, and MATHIAS SALOMO² — ¹PAF, Exp. Physik 1, Universität Leipzig, Linnéstr. 5, 04103 Leipzig — ²Biophysik, Universität Leipzig, Linnéstr. 5, 04103 Leipzig

Optical tweezers are employed to measure the forces of interaction between single DNA-grafted colloids. Parameters to be varied are the length of the DNA (1000 base pairs (bp) to 6000 bp), the grafting density (1.84×10^{-4} chains/nm² to 1.97×10^{-5} chains/nm²) and the ionic concentration (1E-5 M to 10 mM NaCl) of the surrounding medium. From the measured force-separation dependence an interaction-length at a given force (2pN) is deduced. It shows in the mushroom-regime a scaling with the grafting density which levels off for brushes. For the latter the transition from an osmotic to a salted brush can be traced in detail by varying the ionic concentration in accordance with meanfield theories. Further experiments are carried out to measure the influence of the valency of the added salt. Special emphasis is given to the interaction between one DNA-grafted and one blank colloid. The results are discussed with respect to the different brush regimes.

[1] K. Kegler, M. Salomo, and F. Kremer, in Press Phys. Rev. Lett.