

THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN NATURAL
SCIENCE, WITH FOCUS ON CHEMISTRY

A Waterborne Colloidal Model System Consisting of Fluorinated Spheres Bearing Grafted PEG: Synthesis, Characterization and Properties

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Abstract

Model systems have expanded our knowledge of numerous phenomena in Colloid Science, such as the appearance of glasses, order-disorder transitions involving crystals and attraction-induced formation of gels. So far, the existing colloidal model systems have been limited mainly to nonaqueous media. Given that water is such an important solvent, an aqueous colloidal model system is called for.

Here we present such an aqueous colloidal model system with core-shell particle morphology, where the interior is composed of spherical fluorinated cores and the exterior of a poly(ethylene glycol) (PEG) polymer graft. To synthesize these colloids, we have adopted a semi-batch emulsion polymerization, in which the initiator is slowly fed into the reaction mixture. Using this approach not only can monodisperse, low refractive index and sterically stabilized colloids be produced, but also various lengths of the PEG polymer could be successfully grafted onto the particles. Throughout this thesis, several different instrumental techniques have been used to gain an insight into the collective phenomena of these particles and how particle interactions contribute to the observed phase behavior.

Although steric stabilization is very robust way of stabilizing colloidal particles against aggregation, attractions between particles can nevertheless appear, e.g. through the addition of certain salts or addition of a non-solvent. The origin of these attractions is not fully understood. Our results show that colloidal stability increases with decreasing length of the steric stabilizer and that the polymer graft contracts as the solvent quality is worsened. The contraction is accompanied by moderately strong attractions even though the van der Waals force due to core-core interactions is essentially absent. It follows that the attractions are caused by purely polymer-mediated interactions.

Keywords: Colloidal model system, steric stabilization, core-shell, poly(ethylene glycol) (PEG), heptafluorobutyl methacrylate (HFBMA), fluorinated, polymer, phase behavior, short-range attractions, semi-batch emulsion polymerization, small angle X-ray scattering (SAXS), smearing effects, dynamic light scattering (DLS), cryogenic-transmission electron microscopy (cryo-TEM)



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