Experimental report

07/03/2022

Proposal: 9-12-620 **Council:** 4/2020

Title: The mechanism of charging polymer colloids in low dielectric media

Research area: Chemistry

This proposal is a new proposal

Main proposer: Julian EASTOE

Experimental team: Hartmut LEMMEL

Local contacts: Sylvain PREVOST
Hartmut LEMMEL

Samples: dodecane-AOT surfactant - PMMA polymer colloids

Instrument	Requested days	Allocated days	From	To
D11	2	2	07/03/2021	09/03/2021
S18	3	3	09/03/2021	12/03/2021

Abstract:

Fifteen years ago, a group from Harvard published a landmark paper reporting that Aerosol OT (AOT) surfactant could be used to charge sterically-stabilised poly(methyl methacrylate) (PMMA) latexes in nonpolar solvents.1 Due to the low dielectric constants of typical oily media, charged species interact over long length scales.2. Previous studies employed colloids with sizes matched to the Q-range of SANS (diameter <100 nm), which are in fact smaller than those used in real-life applications (diameter 100 nm to 5 µm) such as electrophoretic displays (electronic paper).3 This size discrepancy has resulted in contradictory interpretations of SANS data obtained by our group (surfactant absorbed in the particle cores)4,5 and another group (surfactant adsorbed on the particle surfaces)6. We will resolve this discrepancy in this experiment by studying larger latex particle sizes relevant to applications, which furthermore have form factors that will allow a better differentiation between the absorption and adsorption charging mechanisms.

Title The mechanism of charging polymer colloids in low dielectric media

Proposal number 9-12-620

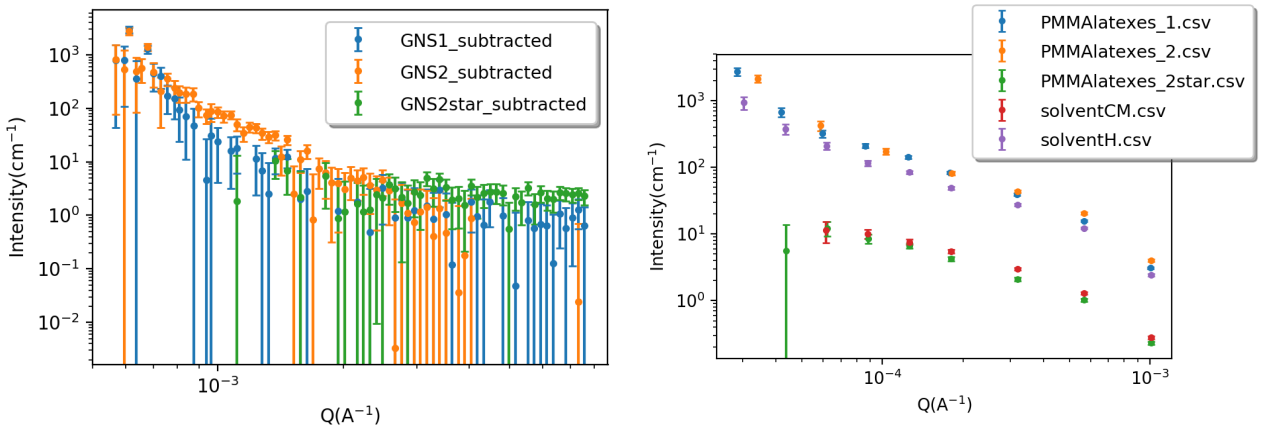
Instruments D11 and S18

Experiment dates From 07/03/2021To 09/03/2021 (D11) and
From 09/03/2021To 12/03/2021 (S18)

Large (1 μm radius) PMMA latexes were dispersed in solutions of deuterated AOT-d_{34} of varying concentrations. Unfortunately, the deuterated AOT was insufficiently pure, and this resulted in the formation of large aggregates of insoluble inorganic material in all samples containing AOT. The scattering could not be distinguished from that of the latexes, which made analysing the distribution of deuterated AOT within the latexes impossible.

The latexes without surfactant were prepared in three background mixtures of H/D dodecane with different SLDs (GNS1: -4.5e-6 Å^{-2}, GNS2: 0.9e-6 Å^{-2}, and GNS2star: 1.1e-6 Å^{-2}). Both the USANS and SANS data of the GNS2star dispersions of latexes gave essentially no scattering, confirming that the SLD of these latexes was equal to that of PMMA homopolymer. This could not be validated *a priori* and without neutrons, and this is valuable information for future SANS/USANS experiments.

The figure below shows relevant data from D11 SANS (left) and S18 USANS (right). For SANS, the GNS2star sample has no scattering above the solvent background; at low Q, the lack of green data points is simply oversubtraction. For USANS, the samples are not solvent subtracted, but the amount of scattering in the 2star sample is essentially equal to the solvent CM, which shows that there is no scattering above the solvent. This confirms that the solvent SLD of GNS2star is equal to that of the PMMA latexes.



Report by Gregory Smith (4 March 2022)