Gold Nanocrystal Superlattices: A Small Angle Neutron Scattering Study

M. Karg

University of Bayreuth, Physical Chemistry Department, Bayreuth, Germany
E-Mail: Matthias.karg@uni-bayreuth.de

The assembly of metal nanoparticles into superstructures with mm or even cm dimensions is a challenging scientific task. Despite the large quantity of monodisperse nanoparticles needed, the loss of colloidal stability is a major limitation to be overcome if such mesoscopic assemblies are of interest.

We coated gold nanocrystals with homogeneous cross-linked polymer shells resulting in core-shell hybrid particles with well-defined structures [1]. The polymer shells are composed of poly-*N*-isopropylacrylamide (PNIPAM), which is a thermoresponsive material. Due to the addition of this polymer shell, the effective particle volume of the nanoparticles is increased significantly. This allows reaching large particle volume fractions with a comparably low particle number.

Crystallization of these hybrid particles was observed over a broad range of particle concentrations at (and below) room temperature. Upon an increase in temperature, the PNIPAM shells shrink and the overall particle volume fraction decreases. This causes melting of the crystals in a certain concentration range. Upon cooling, crystallization occurs again, once a critical volume fraction is reached. These melting/recrystallization processes were observed to occur with very high reproducibility as will be demonstrated in this contribution.

Structural insights of the superlattices were obtained using Small Angle Neutron Scattering (SANS). In the low concentration regime, where inter-particle interactions can be neglected, the particle form factor P(Q) was determined. In contrast, the scattering profiles for crystalline samples contain information on P(Q) as well as on the structure factor S(Q). Scattering profiles were recorded and analyzed for a broad range of concentrations and a variety of temperatures to study the phase behavior of the superlattices.

References

[1] M. Karg, S. Jaber, T. Hellweg, P. Mulvaney, Langmuir **27**, 820-827 (2011)
[2] M. Karg, T. Hellweg, P. Mulvaney, *Adv. Funct. Mater.* **21**, 4668-4676 (2011)