Tunable band-gap colloidal crystals made of gold-Poly-NIPAM core-shell hybrid microgels

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Gold-Poly-N-Isopropylacrylamide (Au-PNIPAM) hybrid microgels with a well-defined core-shell structure were prepared by a new and versatile protocol [1]. The synthetic route allows one to control the shell thickness, the swelling ratio of the shell as well as the use of different sized gold cores resulting in an extremely high yield of core-shell particles with only a single core and a low polydispersity in terms of the overall hybrid size. We present here our recent results on the formation of colloidal crystals made of these Au-PNIPAM hybrids. Due to their responsive shell, temperature can be used as an external parameter to control the degree of crystallization (see fig. 1, left).

Fig. 1: Left: Photographs of concentrated dispersions of a Au-PNIPAM core-shell microgel in a 1 mm quartz cell at various temperatures. Depending on the cooling rate, different macroscopic orders can be achieved (bottom row on the left). Right: UV-vis spectra of a hybrid sample recorded as a function of cooling time after heating to 40°C. The inset shows the increase of the diffraction peak intensity as a function of time determined from the spectra.

Depending on the volume fraction, strong diffraction in the visible can be obtained. By tuning the temperature the crystals can be reversibly melted. Measurements during a cooling cycle show an increase in crystallinity as evidence from an increasing diffraction peak (see fig. 1, right).

We used electron microscopy, atomic force microscopy, UV-vis spectroscopy and light scattering to investigate the structure and responsive behavior of our new “smart” hybrids. Furthermore, studies on 2D- and 3D-arrangements of the particles were done with different methods including laser diffraction and confocal microscopy.

Inorganic/organic hybrid materials have gained enormous popularity within the last decade [2,3]. This work extends the present investigations to core-shell systems and new features are presented.