Colloidal guest particles stabilize cubic structures of monoolein in water

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**Introduction**

The cubic mesostructures (Ia3d, Im3m, Pn3m) of monoolein (MO) in water have watered a lot of interest because of their possible applications in membrane protein crystallography, catalytic surface reactions, and drug delivery. The presence of small particles in the nanoscopic range within the aqueous phase may disturb the initial structure and result in the formation of modified phases, with consequences regarding the above-mentioned applications. Here we present results from a systematic study of such systems, based on MO, water and small water-soluble nanoparticles (NPs) of gold.

**Method**

- **Instrument**
  The samples were studied by SAXS/WAXS with an operation energy of 11.6 keV at the MS-powder beamline X04SA at the PSI, Villigen, Switzerland.

- **Sample preparation**
  Samples were prepared in narrow (0.5 mm) glass capillaries as schematically shown in Fig. 1. The aqueous phase (with or without NPs) was added such that it was in contact with the dry MO.

- **Cubic phase**
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- **Analysis**
  Scattering signals were analysed for patterns agreeing with the known structures for MO (Pn3m, Im3m, Ia3d, hexagonal, and lamellar). From the peak position the lattice constant a was determined.

![Figure 1: Procedure for preparing samples in glass capillaries.](image)

**Results**

- **Reference behavior**
  The results are summarized in a plot with the found lattice constant as a function of temperature shown in Fig. 4.

- **Effect of incorporated NPs**
  The cubic structures are stabilized with increasing concentration of NPs

  - An initial Im3m phase is induced by the presence of the big (5 nm) NPs
  - Hexagonal
  - Cubic
  - Cubic (Pn3m)

  ![Figure 5: Transitory structure diagrams for systems with varying concentration, NPs of 1.8 nm NPs and 5 nm NPs in the aqueous phase. The effective concentration in the cubic phase is unknown. Reference state corresponds to absence of NPs.](image)

**Conclusion**

The systematic study on the structure of a MO cubic in the presence of Au-NPs shows that

- guest particles modify the details of the host cubic phase
- the solid metallic NPs stabilize the cubic structure of their host
- the equilibrium structures containing NPs are left to be found
- possibly the presence of the big NPs enforces the Im3m symmetry as equilibrium structure

**References**


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