Phase transition in phosphocholine micellar solutions induced by lanthanide salts

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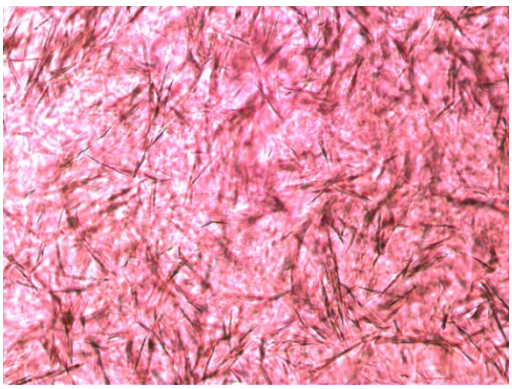
Lanthanide–lipid interactions are important in both fundamental soft matter research and biophysical applications, including magnetic resonance imaging (MRI) and fluorescence-based cell labelling [1,2]. In this work we investigate the interactions between different lanthanide salts and lipid aggregates of the single-chain phospholipid surfactant dodecyl phosphocholine (DPC). DPC is an excellent membrane-mimetic model, used to solubilize membrane proteins in aqueous solutions. Understanding its interactions with lanthanides is expected to clarify lanthanide interactions with cell membranes. In previous work [3], we showed that at low concentrations lanthanides interact with DPC micelles not only as the bare trivalent cations, but also complexed with the anion of the lanthanide salt (chloride, nitrate, bromide, sulfate). In the present investigation we focus on the phase transition that occurs when lanthanide concentration exceeds a critical threshold. Even at low DPC concentrations (12-24 mM) lanthanides form precipitates with DPC, which have a needle-like shape, and a layered structure, as revealed by X-ray diffraction. We study this phase transition using rheology and optical microscopy and follow its evolution using small-angle X-ray scattering. The picture that emerges is very complex. The phase transition depends on the lanthanide cation but also on the anion of the lanthanide salt, being more pronounced for more strongly coordinating anions (e.g. nitrate or bromide vs. chloride). This is also a temperature-sensitive phenomenon. We have created maps of critical salt concentration vs. temperature for several different lanthanide salts. The effects observed are related to the gelation and fusion of lipid vesicles by lanthanides [4,5], although in the present case the integrity of DPC micelles is destroyed and new structures are formed. A mechanism for the phase transition is proposed

Keywords:
Lanthanide-lipid interactions, specific ion effects, lanthanide coordination, surfactants, phase transitions



Needle-like aggregates formed in DPC-CeBr3 solutions at room temperature

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