Lyotropic Liquid Crystalline Mesophases of Mixed Surfactant:Transition Metal Aqua Complex Salts

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The solubity of transition metal salts (TMS) in Lyotropic Liquid Crystalline Mesophases (LLCM), formed by the binary sytems of Oligo ethylene oxide type nonionic surfactants (such as; 10-lauryl ether ($C_{12}H_{25}(OCH_2CH_2)_{10}OH$, represented as $C_{12}E_{10}$) with water (water-$C_{12}EO_{10}$), is limited[1]. Isotropization starts at around 1.0 metal ion/surfactant mole ratio in the water-$C_{12}EO_{10}$ LLCM[1]. The amount of TMS ($[M(H_2O)_n](X)_m$, where M= Co(II), Ni(II), Mn(II), Cd(II), Zn(II), n= 4 or 6, X= Cl^-, ClO_4^-, NO_3^-, Br^-) can be further incresed in the TMS:$C_{12}EO_{10}$ mesophases[2]. The hydrogen bonding between the coordinated water molecules and ethylene oxide group is much more stronger in the TMS:$C_{12}EO_{10}$ as compared to the hydrogen bonding between free water and ethylene oxide in the binary $C_{12}E_{10}$:water systems[2]. The isotropization Temperature (T_i) increases with increasing metal ion concentration in the TMS:$C_{12}EO_{10}$ mesophase. This allows better stability and higher solubility for TMS in the system. However, the TMS: $C_{12}E_{10}$ system either crystallizes out the metal salts or becomes liquid around 4.0 salt/surfactant mole ratio[2]. In this study, a charged surfactant is introduced (either cationic (CTAB) or anionic (SDS)) as an additional component to the TMS:$C_{12}E_{10}$ mesophases and the TMS/$C_{12}E_{10}$ mole ratio can be increased up to 8.0, which is a record high metal ion concentration in known LLCMs[3]. For a broad range of temperature and concentrations 2D or 3D hexagonal phases are observed (see Figure 1.). Maximum ionic surfactant loading is around 0.75 ionic surfactant/$C_{12}E_{10}$ mole ratio and the amount of metal ion that can be introduced, increases with increasing amount of ionic surfactant. Thermal and structural properties of the new system is investigated with X-ray diffraction, FT-IR and Raman Spectroscopy and POM tecniques.

References:

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Figure 1.: POM images of commonly observed 2D(left) and 3D(right) hexagonal structures at two different salt concentrations.