Phase diagrams come alive!
Equilibrium phase diagrams rationalize results of chemical reactions in surfactant systems
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Chemical reactions in aqueous surfactant systems often give rise to drastic changes in structure and macroscopic appearance of the systems. A well-known example concerns the polymerization of silica in a surfactant solution. This can result in the production of a concentrated precipitate phase of highly ordered mesoporous silica with a hexagonal or a cubic internal structure.

We have studied the outcome of chemical reactions that produce insoluble bulk or particulate "soft" structured materials based on "complex salts" of surfactant ions with polymeric counterions. One class of systems was produced by polymerizing the acrylate counterions to cationic trimethyl alkyl ammonium (C₃TA⁺) surfactants [1]. Another class of responsive or self-evolving systems was obtained by hydrolysis of a cationic decyl betainate surfactant in its mixtures with polyacrylate or poly(styrene sulfonate) [2]. In both types of system, very different end results could be obtained, depending on the exact composition of the initial mixture.

Importantly, we could understand, and often even predict, the rich variety of structures resulting from the chemical reactions by studying phase diagrams containing, as components, analogues of the reactants and products of the above chemical reactions. This is the key message of this presentation. Thus, the results of polymerizing acrylate to polyacrylate are predicted by phase diagrams for aqueous C₃TA⁺ surfactants with mixed monomeric and polymeric counterions.[1] Similarly, the result of degrading decyl betainate [2] can be understood from phase diagrams where a long-chain alcohol - one of the products of degrading decyl betainate - is mixed with a cationic surfactant with polymeric counterions.

Our studies point to strategies where physical insight can replace trial-and-error approaches to the production of structured surfactant-based materials by polymerization or degradation reactions.