Microscopic and rheological origins of phase separation in Aqueous Biphasic Systems

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Liquid-liquid extraction is a process widely used in the separation of substances. More specifically, for the separation of metals in recycling. Traditionally, systems composed of an aqueous and an organic phase are used, but these exhibit carcinogenic properties. It is in this context that aqueous biphasic systems have begun to attract attention due to their lower toxicity. The ionic liquid tributyltetradecylphosphonium chloride ([P44414]Cl), mixed with an inorganic salt (NaCl) and water, belongs to this family of mixtures. This system, which is initially monophasic when composed of ionic liquid and water, becomes biphasic when a sufficiently large amount of salt is added [1]. Furthermore, it displays a Lower Critical Separation Temperature (LCST).
Understanding self-organisation and the fundamental mechanisms of phase separation is of paramount importance for extraction applications. We therefore propose to combine small-angle neutron scattering (SANS) measurements with rheological measurements for different compositions. In the absence of salt, the ionic liquid organises itself as a nanosuspension of spherical ionic liquid objects in water, which reverses at high concentrations of ionic liquid, forming water-based hard spheres in ionic liquid.
We also show that the addition of salt induces a change in the composition of the objects as well as their shape, leading to a non-linear evolution of viscosity.
Understanding the mechanisms of metal ion diffusion is also important in the context of metal separation. We are also studying the diffusion of metal ions within each phase independently of the biphasic system, as well as the impact of the liquid-liquid interface on this phenomenon.

Keywords:
Aqueous Biphasic System, Small Angle Neutron Scattering, Rheology, Phase separation

References:

[1] Schaeffer. PCCP. 2019