Confined Coacervation Molecular Membrane Encapsulation Based on Polymer-Surfactant Multiscale Self-Assembly Structures

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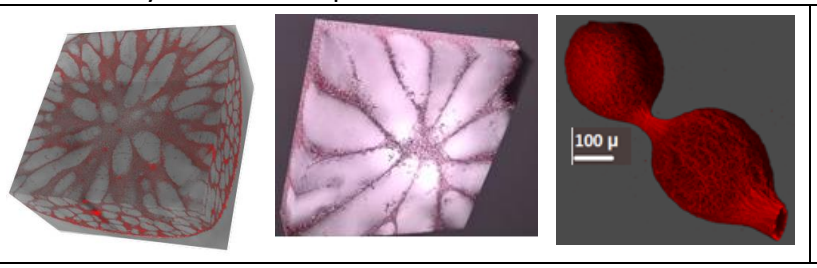
Coacervation of oppositely charged polymers, and polymer surfactant (PS) mixtures are known as one of the most interesting systems for creation of self-assembly structures and microencapsulation with several applications in food and pharmaceutical industries, health care products, adhesion, wastewater treatment, etc. The related phenomena are extensively investigated for oppositely charged polyelectrolytes, however less investigated for PS mixtures, while it can be even more interesting and challenging due to variety of the governed length scales and force levels. The binding of ionic surfactants onto oppositely charged polyelectrolytes can result in associative phase separation with the gel-like concentrated phase (coacervate) and multiscale self-assembly structures, governed by combination of electrostatic and hydrophobic interactions However the existence and percentage of such multiscale complexes are influenced significantly by the basic molecular properties of the PS, and also the solution properties (pH, Temperatures, salinity, etc) and the successful design of an appropriate coacervation process needs certain knowledge.

The conventional approach for producing and investigation of such coacervation processes is to mix them in water to study the phase separation and formed structures in a premixed system under different conditions. In this research work a novel “Confined Coacervation Encapsulation (CCE) Material and Method” is introduced, in which, the Polyelectrolyte Solution (e.g. Xanthan Gum), is inserted into the surfactant solution (e.g. CnTABs), under controlled injected/dripping mode. A sudden formation of shell-membrane at contact interfacial area of two solutions, occurs within a few milliseconds, due to a fast self-assembly process of the PS complexes, formed under certain conditions, so fast that prevents any further direct mixing of two solutions. Afterwards a diffusive process from surfactant solution to the confined polymer solution (in a spherical droplet or tube-like jet), cause a self-control progressive coacervation and internal multilayer process structure formation. The influence of the surfactant type and concentration will be discussed during the presentation, including confocal microscopy results, and the particular application of this novel system for complex waste water treatment.



Confocal microscopy results used for capturing confined coacervation, phase separation, self-assembly structures and membrane formation.

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2- L. Chiappisi, et. al., Soft Matter 9.15 (2013): 3896-3909.
3- M. Koolivand-Salookia, Colloids and Surfaces A, 562, (2019), 345-353.
4- A.Javdi, et al. to be submitted to the Nature Material, June 2019.