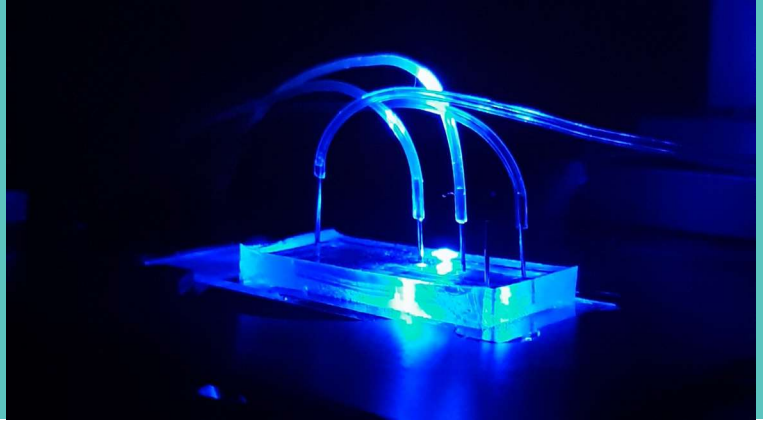

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Biopolymer assembly mediated by biomimetic microreactors

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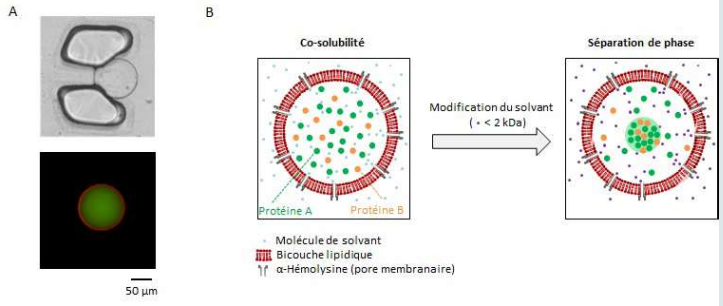
Cochereau R *et al.*

Semi-permeable vesicles produced by microfluidics to tune the phase behaviour of encapsulated macromolecules.

Journal of Colloid and Interface Science . 2020 - https://doi.org/10.1016/j.jcis.2020.07.022



@Rémy Cochereau
Microreactors–Scheme

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Context

Biomass is a precious asset. Optimal upvaluing of biomass requires a firm grasp of the assembly mechanisms of the biopolymer scaffolds. These biopolymers can form a huge spectrum of different assemblies, from crystalline structures to amorphous aggregates and back to highly-ordered fibre architectures. These assemblies are formed by interactions that depend on the molecular properties of the biopolymers but also on the governing physical–chemical conditions (pH, temperature, ionic strength, and so on). The thermodynamic pathway adopted by the system can also play critical role in shaping its final structural state. In an effort to methodize this thermodynamic pathway and make it custom-tuneable, we purpose-developed a set of microreactors in a design inspired by living cells.

Results

The design process used microfluidics to produce and trap giant unilamellar vesicles (GUV) encapsulating macromolecules. The GUVs were generated from dual-compartment emulsions that are diameter-tuneable within a 20µm–110µm range. We demonstrated that their permeability to ions and small (< 2 kDa) molecules could be made tuneable using a pore-forming protein called α-hemolysin. These vesicles can be purposed to (i) encapsulate biopolymers in their ideal solubilization conditions, (ii) modify the quality of the solvent (pH, ionic strength, reducing agents, and more) through controlled exchanges across the lipid membrane, and (iii) probe phase transitions and their allied structural properties. We used these biomimetic microreactors to unlock evidence of a liquid–liquid phase separation process, dubbed coacervation, in wheat protein dispersions.

Future outlook

Now, they are ready to be mobilized to study the structure and dynamics of biopolymer complexes and start to construct a firm understanding of their underlying stucturational pathways. We anticipate this research as a starting point to innovate the use of controlled food-protein assemblies to encapsulate bioactive compounds or to texturize food products. The microreactors developed here could also be mobilized to serve research into the enzymatic hydrolysis of complex assemblies.