Reactive Hexayne Precursors for Microfluidic Production of Carbon Microcapsules

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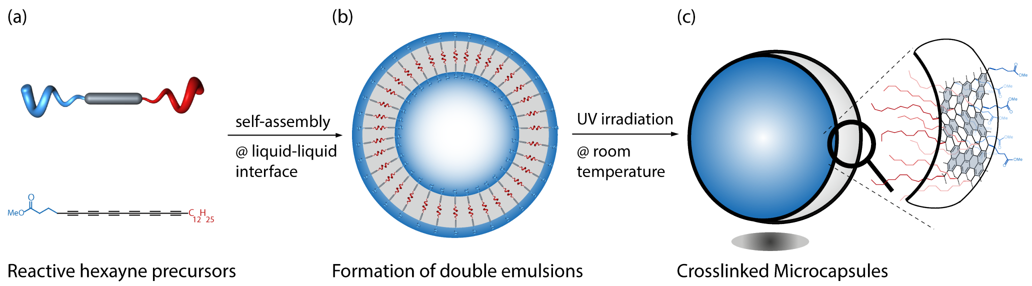
Liposomes are defined vesicular aggregates formed from small amphiphilic organic molecules. The formation of liposomes is an important way to achieve compartmentalization in nature, and synthetic liposomes often serve as simplified model systems to study the behavior of biological membranes with regard to their permeability and their uptake-and-release properties. The work presented here has aimed to prepare "carbosomes" as a novel type of vesicular, synthetic materials that resemble liposomes but have a carbon shell. The "carbosomes" we have prepared represent microcapsules that are fabricated from carbon-rich, amphiphilic precursor molecules (Figure 1).



These precursors have a polar head group, a reactive segment of twelve *sp*-hybridized carbon atoms, and a hydrocarbon tail. Previous investigations of the self-assembly of carbon-rich amphiphiles at the air-water interface showed that flat carbon nanosheets are accessible already under mild conditions, such as UV irradiation at room temperature [1, 2]. We self-assembled these precursor molecules at the oil-water interface using microfluidic drop emulsification, which allows us to create oil-in-water single emulsion or water-in-oil-in-water double emulsion droplets with defined size and composition. The goal is to obtain extensively cross-linked carbon-rich capsules with a diameter on the order of micrometers that have a defined chemical surface functionalization and are constituted from an ultrathin carbon shell with a thickness of 2–4 nm. Such microcapsules are expected to combine a low shell thickness similar to biological cells or synthetic liposomes with the mechanical rigidity and electrical properties of carbon nanomaterials. Thus, the project is expected to deliver insights into the mechanical stability and porosity of these microcapsules. Furthermore, it provides an interesting platform to study fundamental questions of surfactant self-assembly, such as the effect of an ionic or non-ionic precursor on the shell density of the crosslinked microcapsule and the carbon microstructure within the shell.

[1] Stephen Schrettl, Cristina Stefaniu, Christian Schwieger, Guillaume Pasche, Emad Oveisi, Yannik Fontana, Anna Fontcuberta i Morral, Javier Reguera, Riccardo Petraglia, Clémence Corminboeuf, Gerald Brezesinski, Holger Frauenrath, *Nature Chemistry*, **2014**, 6, 468-476.
[2] Stephen Schrettl, Bjoern Schulte, Cristina Stefaniu, Joana Oliveira, Gerald Brezesinski, Holger Frauenrath, *Journal of Visualized Experiments*, **2016**, 109, e53505.