Master Thesis Project // Van ‘t Hoff Laboratory of Physical and Colloid Chemistry

Sustainable synthesis of fluid-bicontinuous gels with controlled liquid-liquid domain sizes

Supervision: Henrik Siegel (h.siegel@uu.nl) & dr. Martin F. Haase (m.f.haase@uu.nl)

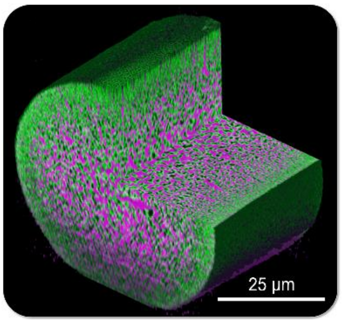

Fig. 1. 3D reconstruction of a nanostructured bijel fiber with water channels marked in magenta, oil channels in black and nanoparticle scaffold in green. Image taken from [2].

High-surface area separation membranes are important materials to supply people with clean water in times of increasing global water scarcity. A new and promising material for the fabrication of high-surface area membranes are fluid-bicontinuous gels [1, 2]. Fluid-bicontinuous gels are a class of soft matter composed of interwoven liquid-liquid channels which are obtained from the demixing of oil and water [3, 4]. The porous channel network evolves from the self-assembly of nanoparticles at the oil/water interface arresting the demixing process. Figure 1 shows the structure of the resulting bicontinuous interfacially jammed emulsion gel (bijel).

So far, bijels are made from complex precursor dispersions in a process that includes hazardous and environmentally harmful chemicals such as cetrimonium bromide, toluene or diethyl phthalate [4]. We aim at establishing an environmentally-friendly route to produce nanostructured bijels. Our approach is to use water instead of toluene as synthesis medium and we employ a surfactant-free precursor system that contains covalently-functionalized nanoparticles.

In this project, we design a new bijel precursor composition for the fabrication of high-surface area separation membranes. We use silane chemistry to modify the oil/water wettability of nanoparticles and analyze the nanoparticle wetting via contact angle measurements. The characterization of the silane modification is complemented by thermogravimetric analysis and FTIR spectroscopy. Bijels are subsequently fabricated in a continuous flow process and the bijel structure is analyzed via scanning electron microscopy and confocal laser scanning microscopy. For the bijels obtained we aim on identifying the parameters that control the liquid-liquid domain sizes. Finally, chemical post-treamtents are tested to optimize the mechanical properties of the bijels. This knowledge is used to produce bijel-templated membranes via a sustainable route.

References

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