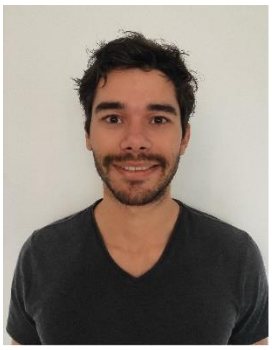
Electro-osmosis and biphasic catalysis in bijels



Alessio Sprockel, a.j.sprockel@uu.nl

Sponsor: ERC since January 2020
Supervisors: Dr. M.F. Haase

Keywords: bicontinuous emulsions, Electrokinetics, biphasic catalysis

Chemical reactions involving 2 immiscible liquid reactants and solid catalyst particles are limited in their reactivity because the catalytic sites are typically not accessible to both reactants. However, by locating the catalyst particles at the interface of two immiscible reactants, all three participants meet and the reaction can proceed swiftly. Based on this concept, we employ colloidal particles at interfaces to structure liquids into a long network composed of microscopic channels, a material known as a bijel fiber. (fig. 1A) The large surface area of a bijel enhances the reactivity because it facilitates intimate contact between reactants and catalysts. Moreover, the two interwoven channel networks of oil and water allows reactants to flow in, and products to be continuously withdrawn. This approach shows promises to introduce a new chemical technology for the synthesis of high value-added chemicals. However, before industrial implementation can be realized, several research questions still need to be investigated.

Research is now focused on three main topics, all working towards continuous biphasic catalysis. Firstly, learning how to better control the bijel formation process. Currently, silica particles are placed on the interface, to realize catalysis in a bijel, bijels containing catalytic particles are required. Secondly, we investigate the flow of liquids through the bijel fiber. A convective flow is required to sustain a catalytic reaction. Pressure driven flow is impractical through the long submicron water pore network, so we make use of electro-osmotic flow. (fig. 1B) With the help of confocal microscopy, we investigate the behavior of the liquid flow through the complex material on micron scale. Lastly, the synthesis of dyes inside the bijel is used to learn about its catalytic activity and limitations. (fig. 1C) The reaction rates will provide us insight on how the unique system can be employed in an industrial setting.

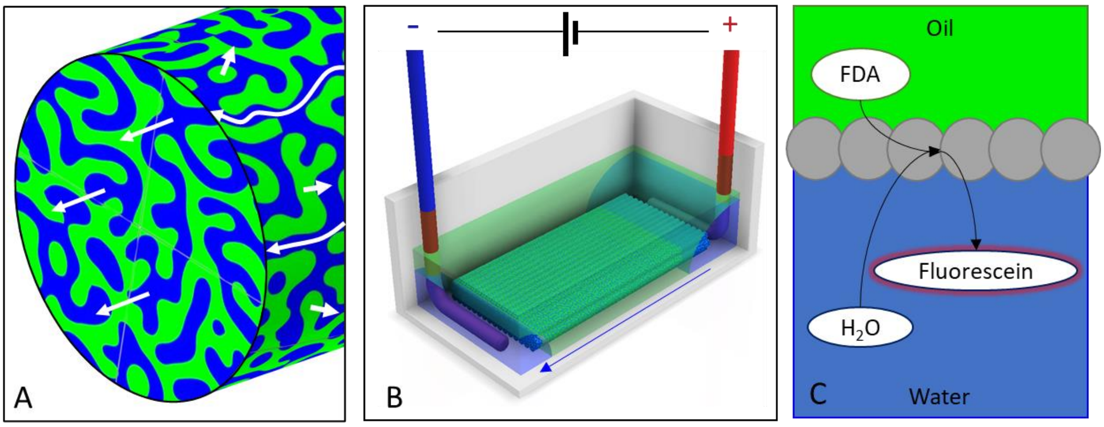


Figure 1: A) Schematic of the bijel fiber, with water (blue) and Oil (green) networks intertwined. B) Schematic of parallel fiber electro-osmosis setup. C) Catalytic conversion of Fluorescein diacetate to fluorescein.