Programmable life-like materials that organize at mesoscopic scale.

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Living matter has unique properties that are a great source of inspiration to create new materials with unprecedented characteristics. Our Life-like Materials group aims to create dynamic assemblies that spontaneously emerge from molecular building blocks and organize at larger length scales, while adapting to stimuli from their environment.

Inspired by the self-organization of slime mold organisms that grow into long wires and form networks while exploring surfaces to localize food sources, we developed a chemical system that assembles into centimeter-long filaments and concomitantly coordinates the spatial self-organization of free-floating droplets at aqueous interfaces. At the core of our system is an amphiphile molecule that forms myelin filaments that emerge from floating reservoir droplets. Marangoni flows direct the progression of these filaments towards drain droplets that deplete amphiphile surfactants from the air-water interface. A simple model rationalizes how the repulsive and attractive forces that are generated as both the Marangoni flows and the filaments organize between source and drain droplets sustain autonomous positioning of dynamic assemblies at the mesoscale.

We foresee that these principles will contribute to autonomously operating chemical systems at mesoscopic scale that determine which points on a substrate become connected via transporting filaments; opening new potential in for example bottom-up microfluidics where connections are not dictated via static channels, but spontaneously emerge and re-wire when required.