Self-propelling Droplet Shells Stabilized by Liquid Crystal Topology

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Liquid shells e.g. double emulsions, vesicles etc. are susceptible to interfacial instability and rupturing when driven out of mechanical equilibrium. This poses a significant challenge for the design of liquid shell based micro-machines, where the goal is to maintain stability and dynamical control in combination with motility. Here we present our solution to this problem with controllable self-propelling liquid shells, which we have stabilized using the soft topological constraints imposed by a nematogen oil. We demonstrate, through experiments and simulations, that anisotropic elasticity can counterbalance the destabilizing effect of viscous drag induced by shell motility, and inhibit rupturing. We analyse their propulsion dynamics, and identify a peculiar meandering behaviour driven by a combination of topological and chemical spontaneously broken symmetries. Based on our understanding of these symmetry breaking mechanisms, we provide routes to control shell motion via topology, chemical signalling and hydrodynamic interactions

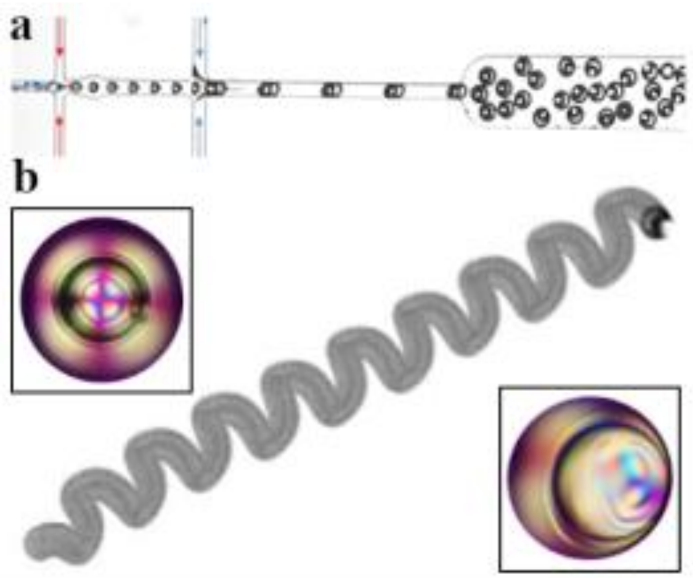

Fig. 1. **a.** Microfluidic production of monodisperse double emulsions in a flow focusing cross-junction configuration. **b.** Shark-fin meandering of a swimming shell. Top-left and bottom-right insets show example images of shells under cross-polarized microscopy before and during swimming respectively.

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