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Oriented Assembly of Anisotropic Particles by Capillary Interactions

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Particles situated at fluid interfaces occur in nature, with the particles ranging from pollen to insects which walk on water. Particles at interfaces are exploited in classical applications like Pickering emulsions, in which particles stabilize emulsions, and froth flotation, in which ore particle adsorption to fluid interfaces is used to separate and recover metal ores. Particles at interfaces also occur in emerging applications in which nanomaterials are organized at interfaces.

The assembly of particles into ordered structures via capillary interactions is studied. Early work in this field focused primarily on spherical particles that distort fluid interfaces and create excess area. The particles assembled by capillary interactions which occur because the excess area created by the particles decreases as the particles approach each other. Here, particles with shape anisotropy are studied. Such particles create undulations with excess area that can be locally elevated at certain locations around the particle. The local elevation of excess area makes these sites locations for preferred assembly. Hence, particles orient and aggregate in preferred orientations. Such self assembly is often termed directed assembly. Three key issues in directed assembly are means of controlling the object orientation, alignment, and the sites for preferred assembly, including means of promoting registry of features on particles. Each of these issues is addressed in detail in for the example of a right circular cylinder using analysis, experiment and numerics. A series of other shapes are then studied to illustrate the generality of the concepts developed.

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