Guiding Chemical Microswimmers with Patterned Surfaces

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Chemical active colloids moving through a liquid environment employing self-generated chemical gradients serve as a model system for studying active matter. The self-generated hydrodynamic and chemical fields, which induce particle motion, probe and are modified by the environment including its boundaries. We show that near a hard planar wall a chemical microswimmer may exhibit a steady “sliding” motion at fixed orientation and height above the wall or a motionless steady “hovering”. Hovering particles create recirculating regions of flow, and can be used to mix fluid or to trap other particles. Sliding states, on the contrary, provide a starting point to engineer a stable and predictable motion of microswimmers. Thus, for topographically patterned walls, novel states of guided motion along the edges of the patterns emerge when the parameters of the microswimmers are such that a sliding state occurs in the absence of the patterns. Such topography-guided states emerge from a complex interplay between chemical activity of the particle, hydrodynamic interactions and the confinement of the chemical and hydrodynamic fields by the topography. Furthermore, we predict that also by chemically patterning a planar wall one can direct the motion of chemical microswimmers: the induced chemi-osmotic flows at the wall can cause particles to either “dock” at the chemical step between the two materials or to follow a thin chemical stripe.