Studying synthetic micro swimmers near surfaces and using them to build self-assembled machines

Jaideep Katuri, Juliane Simmchen, Laurent Helden, Clemens Bechinger and Samuel Sanchez

Max Plank Institute for Intelligent Systems, Heisenberg straße 3, Stuttgart, Germany
katuri@is.mpg.de

Silica particles asymmetrically coated with Pt, which move in self generated chemical gradients, are model systems in the study of active matter[1, 2]. While there is a relatively good understanding of the motion of single active particles[3], the influence of the surfaces near which they swim is not well understood. Natural swimmers like bacteria show interesting behaviours near surfaces that is different from their bulk properties. There is reason to believe that surface properties can have a significant influence on synthetic swimmers as they propel by phoresis, an interfacial effect. Here, we use catalytically active spherical Janus micro-motors in order to investigate experimentally their motion on substrates of different properties. We use Total Internal Reflection Microscopy (TIRM) to estimate the height at which they swim and establish a relationship between swimming height and swimming speed. We further explore ways to modify this interaction and thereby obtain desired behaviors like directional control. Our understanding of the interaction of swimmers with the surfaces enables us to exploit surface properties to design nano-patters on the surface, much smaller than the radius of the swimmers themselves, to influence their directional behaviour. Further, we are able to use the tendency of self-propelled particles to have stable orientations against obstacles to self-assemble rotors by using a combination of passive and active components. The speed and direction of the rotors can be well controlled leading to very reliable micro-machining systems.

References


Figures

Fig 1. SEM and schematic representation of a self propelled Janus particles near a nano-patterned surface. Minute details of the surface can be used to control the propulsion behaviour of Janus particles.

Fig 2. Schematic representation of the two possible docking events leading to a Janus particle stably propelling the micro-gear.