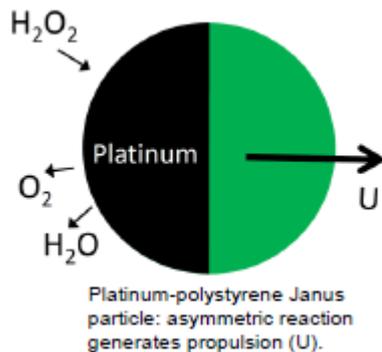


The Physics of Soft and Biological Matter

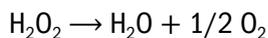
How do platinum janus particles swim?

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Polystyrene particles asymmetrically coated with platinum and dispersed in hydrogen peroxide solution are often used as model colloidal swimmers [1]. They swim in solution by utilising the chemical gradients produced by the hydrogen peroxide decomposing into water and oxygen. However, the precise link between the chemical gradient and the observed swimming is still not clearly understood. Previous observations are consistent with a model where the reaction propels the particle through an osmotic pressure. Simply:



has more products than reactants, so there will be more molecules on the Pt side of the particle, resulting in propulsion away from that side. The previously observed direction of motion [2], and the scaling of speed with particle radius [3] and peroxide concentration [1] are consistent with this simple model.

We have found [4] that the propulsion direction can be reversed by adding an ionic surfactant. This demonstrates that the swimming mechanism is more complicated than this simple osmotic model. Further observations, of the effect of salt on swimming speed, and of the hydrogen peroxide reaction rate, also help us to rule out more complex variations of this model. We suggest, instead, that these particles swim because of ionic currents generated across their platinum surface – a generalization of the mechanism thought to propel bimetallic rods [5].

Understanding the swimming mechanism of these particles is important if they are to be used in more complex experiments, since different swimming mechanisms generate different flow fields and concentration fields around the particle. We show some preliminary experiments on the interaction of these particles with plane surfaces and colloids, which probe the hydrodynamic signature of their swimming mechanism.

- [1] Howse et al., Phys. Rev. Lett. 99, 048102 (2007)
- [2] Ebbens and Howse, Langmuir 27, 12293 (2011)
- [3] Ebbens et al., Phys. Rev. E 85, 020401 (2012)
- [4] arXiv:1312.4130
- [5] Paxton et al. J. Am. Chem. Soc. 126, 13424 (2004)