
nanotechweb.org

TECHNOLOGY UPDATE

Nov 8, 2007

Tiny rods steer themselves

Chemotaxis is the tendency of some biological organisms to move in response to a gradient in chemical concentration – either towards a chemical attractant or away from a repellent. In non-biological systems, chemotaxis could be useful for directing the motion of small particles in fluids or even assembling collections of particles into nanostructures – without the need for applying external electric or magnetic fields. Non-biological chemotaxis could also be used to seek out the presence of certain chemicals in environments that are hostile to living organisms.



Rods on the move

However, chemotaxis in biological cells is extremely complex and this has made it very difficult to mimic the effect in non-biological systems. Now, Ayusman Sen and colleagues at the Pennsylvania State University have come up with a very simple way of doing so. The team made a large number of tiny metal rods that were 2 μm long. Each rod was gold along one half of its length and platinum along the other.

"We picked that size for the rods simply because they are easy to visualize and track by optical microscopy," Sen explained. "There is no obvious reason why the rods or analogous particles cannot be made smaller, although we would need an alternative visualization technique."

The rods were placed in a dish containing pure water and a piece of gel that contained hydrogen peroxide. The hydrogen peroxide slowly leached from the gel into the water, creating a concentration gradient in the surrounding water.

After about 110 hours, the team noticed that more than 70% of the rods had accumulated next to the gel (see [movie \(http://research.chem.psu.edu/axsgroup/documents/supporting_information-unpublished-videos.mpg\)](http://research.chem.psu.edu/axsgroup/documents/supporting_information-unpublished-videos.mpg)). According to the researchers, this movement occurred because hydrogen peroxide

undergoes different chemical reactions at the gold and platinum ends of the rods. This they say, drives fluid along the rod causing it to move. The particles' speed increases with the local concentration of hydrogen peroxide and so on average the rods are "attracted" to the gel – a simple realization of chemotaxis.

Sen told *physicsworld.com* (<http://physicsworld.com>) that the experiment shows that, in principle, it is possible to "build nanomotors 'from scratch' that mimic biological motors by using catalytic reactions to create forces." Sen and colleagues are now investigating the use of light to control photocatalytic reactions on the rods' surfaces thereby mimicking "phototaxis" – whereby organisms move according to changing light levels. This could allow light to be used to create complex arrangements of particles.

Ramin Golestanian, a physicist at the University of Sheffield in the UK who has worked on similar nanopropulsion systems told *physicsworld.com* that the Penn State team has addressed a "fundamental issue" facing those designing tiny swimming machines – how to steer them. According to Golestanian, chemotaxis is nature's solution to the steering problem and it is appropriate for nanotechnologists to "get [their] inspiration from biological mechanisms".

About the author

André Brown (<http://student.physics.upenn.edu/~aebrown/index.html>) is doing a PhD in biophysics at the University of Pennsylvania. Additional reporting by James Tyrrell, editor of *nanotechweb.org*.