Microspiders: Polymerization reaction drives micromotors

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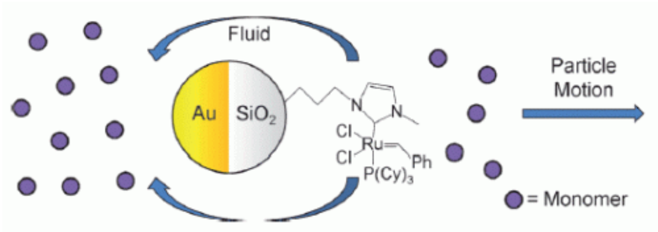

(PhysOrg.com) -- Though it seems like science fiction, microscopic "factories" in which nanomachines produce tiny structures for miniaturized components or nanorobots that destroy tumor cells within the body and scrape blockages from our arteries may become reality in the foreseeable future. Nanomotors could transport drugs to specific target organs more rapidly or pilot analytes through the tiny channels on microchip diagnostic systems. In the journal *Angewandte Chemie*, Ayusman Sen and his team from Pennsylvania State University (USA) describe a new type of micromotor that is powered by a polymerization reaction and deposits tiny threads along its trail like a microspider.

The motors consist of spheres that are barely a micrometer in size, made half of gold, half of silicon dioxide. Certain catalyst molecules (a Grubbs catalyst) that catalyze polymerizations can be attached to the silicon dioxide surface. Sen and his team use norbornene as a monomer. The catalyst opens the rings and strings these monomers together into long chain molecules.

As soon as the reaction begins, the spheres start driving through the surrounding liquid. How is it that such a reaction can cause movement? The secret lies in the two different halves of the spheres. The monomer is only consumed on the side where the catalyst molecules are present. This causes the monomer concentration to decrease until it is lower than on the catalyst-free gold side. The resulting concentration gradient produces osmotic pressure, which causes a tiny current of solvent molecules toward areas with higher monomer concentration-toward the gold side. This miniature current drives the micromotor in the opposite direction.

Somatic cells-in processes such as embryogenesis-and certain single-celled organisms can follow concentration gradients of messenger substances or nutrients, a phenomenon known as chemotaxis. The new micromotors are also capable of such directed movement. The scientists used norbornene-filled gels that slowly leach out the monomer. The micromotors sense this and preferentially move towards the gel, following the nutrient gradient like a single-celled organism. The reason for this is that the polymerization goes faster when there is more monomer near the catalyst. This effect causes the local current driving the spheres to become stronger as well.

It is thus possible to direct the micromotors toward their target. In a solvent where the resulting polymer is insoluble, it could be deposited in the trail left behind; a microspider that moves around weaving a web. The micromotors can also be used to detect defects and fractures, moving towards them and sealing them with polymer.

More information: Ayusman Sen, A Polymerization-Powered Motor, *Angewandte Chemie International Edition*, dx.doi.org/10.1002/anie.201103565

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