



2011 online edition of *Nature Chemistry* (DOI: 10.1038/NCHEM.1195).

The researchers first generate a class of metal-Pt-Fe<sub>3</sub>O<sub>4</sub> heterotrimers. Step-wise thermal decomposition of Fe(CO)<sub>5</sub> in the presence of Pt seed particles generates Pt-Fe<sub>3</sub>O<sub>4</sub> dimers, and subsequent reduction of a chosen metal precursor (for Au, Ag, Ni, or Pd) in the presence of these dimers then results in a high yield of heterotrimer structures. Surprisingly, each reduction reaction resulted in heterogeneous nucleation of the Au, Ag, Ni, or Pd exclusively on the Pt domain of the Pt-Fe<sub>3</sub>O<sub>4</sub> dimers. This occurs as direct contact between the Pt and Fe<sub>3</sub>O<sub>4</sub>

domains facilitates electron transfer to the Pt domain, leading to the observed chemoselective deposition of the metal at the Pt surface.

Heterotetrameric particles were also synthesized by depositing Cu<sub>x</sub>S or PbS domains on Au-Pt-Fe<sub>3</sub>O<sub>4</sub> heterotrimer seeds. Again, while many products would appear to be possible, in both cases the new domain was located exclusively on the Au domain. It was suggested that while sulfur adsorbs to all domains of the heterotrimer, it was selectively localized on the Au due to differences in the rate of sulfur adsorption and reaction with Cu<sup>+</sup> ions at the Au versus Pt surfaces.

The Au-Pt-Fe<sub>3</sub>O<sub>4</sub> heterotrimers were also used to generate higher order oligomers of 2–5 trimers by heating them in the presence of sulfur.

Through this study, the researchers demonstrated that a sequential reaction approach can provide a powerful route to the synthesis of complex hybrid nanoparticles. In combination with existing mechanistic understanding of the reactions involved, this strategy can lead to the rational synthesis of larger multidomain hybrid nanoparticles with increasing architectural complexities.

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### Electrochemically formed gas bubbles serve as propulsion fuel

The design of artificial swimmers and other motion-controlled objects often involves asymmetrical or charged objects. G. Loget and A. Kuhn, from the University of Bordeaux, used

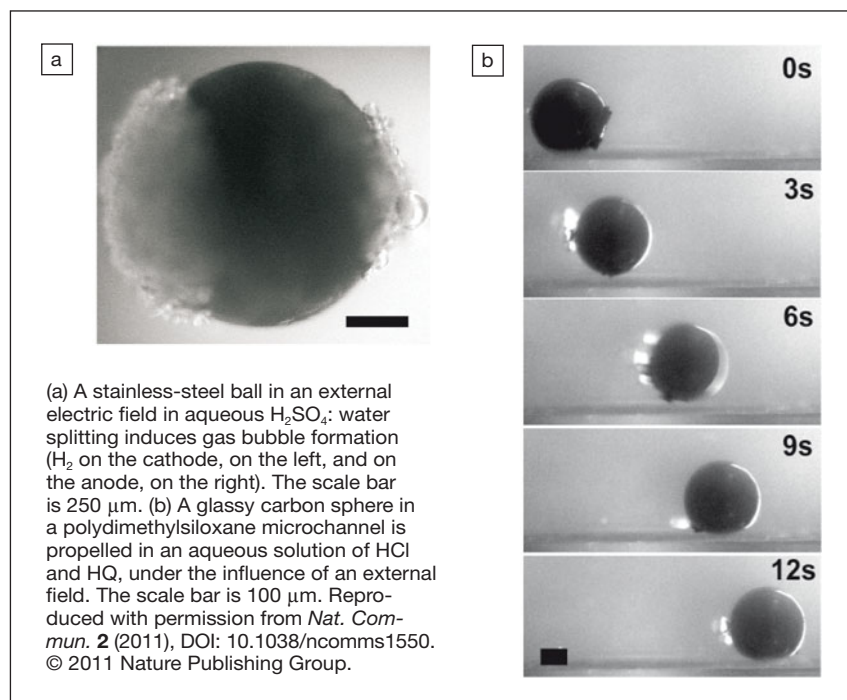
the polarization of conducting materials in an external electric field to operate their swimmers. Bipolar electrochemical reactions at the surfaces of the objects results in the asymmetric production of gas bubbles, which propels the objects.

As reported in the November 15, 2011 online edition of *Nature Communications* (DOI: 10.1038/ncomms1550),

the researchers achieved linear and rotational motions of millimeter-sized conducting objects, due to gas bubble formation. Placing the swimmer between an anode and a cathode induces a potential difference between two opposite sides of the swimmer and electrochemical reactions such as water splitting result in differential gas bubble formation on the object surface. Other electrochemical reactions could also be used to enhance the asymmetry of the propulsion and therefore produce higher speeds. The bubble propulsion was also shown to be more efficient for larger objects where larger potential differences across the surfaces and smaller viscosity effects combine and increase the propulsion.

Macroscopic rotors were also developed based on a similar principle, where exposure of only one small conducting part on each blade causes asymmetrical bubble production. Vertical rotors can also take advantage of the buoyancy of bubbles, pushing the rotor blades up and reaching speeds of 0.70 rpm. Tuning the adherence of the bubbles to the sails then allows optimization of the rotation speed.

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