ARTIFICIAL SWIMMERS

I will message you

Angew. Chem. Int. Ed. **57**, 241–245 (2018)

Some particles can catalyse a chemical reaction in which the release of a gas molecule propels them in solution. A common example of such a reaction is the disproportionation of hydrogen peroxide to water and oxygen by some metals, such as Pt and Ag. If a Janus particle is made so that the catalytic centre is on one side only, the particle will move with a preferred direction. Chen et al. have now shown that a communication system between two different kinds of swimmers can be designed so that one swimmer sends a chemical signal to a second one to increase the propagation speed of the latter.

The microparticle that sends the message is composed of polystyrene half-coated with Ni, Au and Ag layers. The Ni layer serves as a magnetic element to externally guide the particle. The receiver is a SiO_2 Janus particle half-coated with a Pt layer. In the presence of hydrogen peroxide, metallic Ag dissolves in solution to give Ag^+ and oxygen superoxide. If the sender is guided near the receiver, Ag^+ will deposit on top of metallic Pt and reduce to metallic Ag by the action of the oxygen superoxide to form small nanoparticles. In turn, the newly formed Pt/Ag interface catalyses the decomposition of hydrogen peroxide, propelling itself away. Because a Pt/Ag surface catalyses the reaction much faster than Pt alone, the receiver experiences an acceleration of about three to six times, depending on the concentration of hydrogen peroxide in the solution. *AM*

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MEMORY DEVICES

Atomic recall

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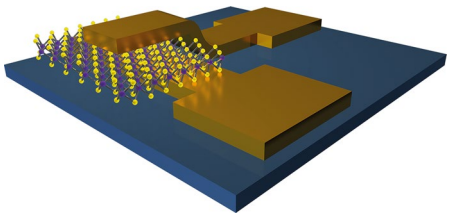

Credit: American Chemical Society

Technological progress in high-density data storage largely relies on the miniaturization of memory devices. To this end, atomically thin materials that set the physical limit for a minimal device-feature size could allow for further memory downscaling. Now, contrary to the commonly accepted belief that non-volatile switching cannot occur in monolayer sheets, R. Ge et al. show single-layer memory devices in a typical vertical metal–insulator–metal (MIM) configuration.

The researchers tested four different monolayer transitional metal dichalcogenides (TMDs) in a crossbar MIM device referred to as an atomristor. The atomic memristor exhibits non-volatile resistance switching that requires no electroforming step, has an on/off ratio above 10^4 and occurs at programming voltages below 1 V. The highly crystalline TMD monolayers form sharp interfaces and clean tunnel barriers with the Au contacts resulting in a significantly reduced leakage current. The experimental results confirm retention of non-volatile states for up to one week and high mechanical cycling endurance in the best-performing MoS_2 atomic switch. Unlike the previous demonstration of a lateral atomic MoS_2 device, the vertical atomristor is better fit for real applications owning to its smaller footprint and low energy consumption. *OB*

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GENE SYNTHESIS

A multiplexing approach

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Gene synthesis is essential for protein designs and many other applications of genes. However, gene synthesis is much less developed compared to gene sequencing and the current step-by-step sewing synthesis approach is quite expensive. Now, Plesa et al. report a much cheaper one-pot method called DropSynth by which they can synthesize multiple genes in parallel from an oligonucleotide microarray.

The DropSynth approach uses barcoded microbeads to pull down the desired oligonucleotides with complementary barcodes from the oligo microarray. The microbeads with captured oligonucleotides are subsequently emulsified into picolitre droplets, where full-length genes with the desired sequences are assembled via polymerase cycling assembly. The resulting sequences are then released from the emulsion droplets by type-IIS restriction enzyme sites. Thousands of synthetic genes that encode homologs of two *E. coli* proteins have been successfully synthesized. The capability of the protein homologs to complement certain functions has been tested using multiplexed functional assays. These results can help improve the understanding of the sequence–function relationship. The DropSynth method requires no specialized equipment, enabling access to a gene pool at a price similar to an oligonucleotide pool. However, one should note that although it is advantageous to obtain large libraries of genes, the method's efficiency to produce a particular gene is too low, which should be improved to meet manufacturing needs. *WS*

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DRUG DELIVERY

Going soft

Nat. Commun. **9**, 130 (2018)

The importance of physico-chemical characteristics such as size, shape and surface chemistry on nanocarrier cellular uptake and in vivo tumour accumulation is widely recognized. On the other hand, the effect of nanocarrier elasticity remains poorly studied, due to the difficult task of suitably modulating this property without affecting other parameters.

Now, Guo et al. address this challenge by synthesizing nanoparticles made of an external layer of liposomes and an alginate hydrogel core. This composition allows production of nanoparticles with homogeneous size and surface chemistry, controlled by the lipid bilayer, and variable elasticity. The addition of different concentrations of calcium chloride during the nanoparticle preparation leads to different extents of alginate crosslinking, which influences the stiffness of the material. The resulting nanoparticles display a range of elasticities, measured in terms of Young's moduli, varying from 45 kPa to 19 MPa. In cellular uptake studies, the researchers show an inverse correlation between nanoparticle elasticity and internalization, with the softer nanoparticles, consisting only of the liposome shell, more readily internalized by both normal and cancer cells. Using fluorescence microscopy, they demonstrate that soft nanoparticles enter the cells by fusing with the cell membrane, while stiffer nanoparticles penetrate via endocytosis, a longer and energetically more expensive process that requires membrane bending, nanoparticle engulfment, endosome formation and release within the cell. Since delivery to the endosome might trigger nanoparticle degradation, tuning the elasticity of nanomaterials to promote direct cytoplasmic delivery via fusion should be beneficial for intracellular delivery. *CP*

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