however, photocycloadditions have been less frequently used. They have proved challenging to perform in an asymmetric fashion because, when using a chiral catalyst, it can be difficult to suppress the background uncatalysed reaction. Now, Richard Brimioulle and Thorsten Bach from the Technical University of Munich have reported that certain [2+2] photocycloadditions can be rendered asymmetric by the application of a chiral Lewis acid catalyst.

The key to Brimioulle and Bach's method was the recognition that coordination of certain substrates to a Lewis acid results in a dramatic shift in their ultraviolet absorption spectrum. This raised the possibility that irradiation at a selected wavelength would excite just the coordinated substrates and result in no competing background reaction. Treatment of a variety of *N*-acylated-5,6-dihydro-4-pyridones (in which the acyl group contains a pendant alkenyl group) with a chiral boron Lewis acid, and irradiation at low temperature with 366 nm light, results in an intramolecular [2+2] cycloaddition to form a cyclobutaquinolizine dione. The reaction has the potential to create four stereocentres and is both highly diastereo- and enantioselective.

Brimioulle and Bach subsequently applied their method to an enantioselective total synthesis of (+)-lupinine and an enantioselective formal total synthesis of (+)-thermopsine — two members of the lupin family of alkaloids. Both syntheses start from a single photocycloaddition product accessed using the new method but then diverge with the introduction of a protected alcohol and a pyridone, respectively. In both cases the cyclobutane ring formed by the cycloaddition is then opened in the course of a Barton–McCombie-type deoxygenation. Simple deprotection affords the parent natural product (+)-lupinine. They also claim formal synthesis of (+)-thermopsine, because the pyridone derivative is the single enantiomer form of an intermediate in a previously reported racemic synthesis. *SD*

NANOREACTORS

Catalysis in compartments

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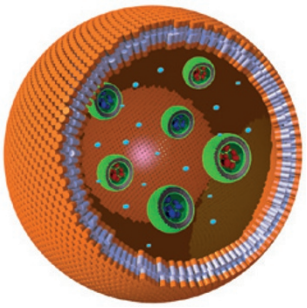
Eukaryotic cells contain small compartments that enable different reactions to be separated in space. This has advantages — for instance in supporting the spatiotemporal control of reactions, the formation of high local concentrations or concentration gradients, or the separation of incompatible reaction components. In an effort to mimic this multicompartment arrangement, a team of researchers led by Jan van Hest from



Radboud University Nijmegen and Sébastien Lecommandoux from the University of Bordeaux have created a cell mimic formed from a series of smaller polymersomes encapsulated within a larger polymersome. This multicompartment system was used to separate the individual steps of a sequential enzymatic cascade reaction.

The outer compartment is a micrometre-sized polymersome made from the block copolymer polybutadiene-b-poly(ethylene oxide). The smaller polymersomes — formed from polystyrene-b-poly(3-(isocyano-L-alanyl-aminoethyl)-thiophene) — reside inside this outer compartment. The team encapsulated different enzymes within different smaller polymersomes and also inside the main cavity. For the catalytic cascade to be successful, the reactants and products of the individual steps need to diffuse across the polymersome membranes while the enzyme catalysts remain within their designated compartment.

In the first step of the catalytic cascade, which takes place inside the main cavity of the large polymersome, a pro-fluorescent substrate is oxidized to an ester by a Baeyer–Villiger monooxygenase and a cofactor. The second step occurs within one of the sub-compartments and involves the hydrolysis of the ester to an alcohol by a lipase. In the third step, which occurs in another polymersome sub-compartment, the alcohol is oxidized to an aldehyde by alcohol dehydrogenase. Finally, the aldehyde undergoes spontaneous β-elimination to give a fluorescent dye — which could be easily detected to confirm completion of the reaction cascade. To demonstrate that the polymersomes-inside-polymersome arrangement is capable of separating incompatible components, the lipase was replaced with a protease that shows esterase activity but also causes the degradation of other enzymes. The dye was also produced in this arrangement, showing that the other enzymatic catalysts were not significantly degraded by the compartmentalized protease. *RJ*

Written by Stuart Cantrill, Stephen Davey, Russell Johnson and Anne Pichon

blogroll

New thinking

Mulling over the Mpemba effect, and a call to read more widely.

A recent post at The Physics arXiv Blog (http://go.nature.com/1gqVdy) tells of a possible explanation for the 'Mpemba paradox': the observation, named after a Tanzanian student, that a hot glass of water will freeze more quickly than a cold one. This puzzling and counterintuitive phenomenon seems to fascinate scientists the world over, and was the subject of a 2012 competition run by the Royal Society of Chemistry that garnered more than 20,000 entries (http://go.nature.com/kGFwSK).

We learn that, according to a new theory (http://go.nature.com/s9d9h8), in warmer water hydrogen bonds expand further and — because of electron-pair repulsions — this compresses the molecules' covalent bonds, leading to a net cooling effect. The calculated energy changes arising from hydrogen-bond stretching accurately predicts the observed differences in freezing speed for water at different temperatures. Yet the post notes that because the paper makes no new predictions, the researchers will still "probably need to work a little harder to convince everyone". An interesting — if unproven — idea, nevertheless.

Elsewhere in the blogosphere there's encouragement to keep reading in unfamiliar places, such as the arXiv blog. A guest post by Nilam Ashra-McGrath at The Thesis Whisperer (a blog encouraging PhD students through their endless toil) has exactly this advice for PhD students: read extensively (http://go.nature.com/JCS6ZI). Ashra-McGrath says her PhD's most frequent highs came when she was "devouring books and taking in ideas quickly [...] making connections between my emerging data and the theories I was reading". As one commenter put it "how do we expect ourselves to make new conceptual connections if we follow the same path as everyone else?" (http://go.nature.com/hiAWGX).

Written by Joshua Howgego, a science journalist at SciDev.Net, whose work can be found at http://www.joshuahowgego.co.uk/