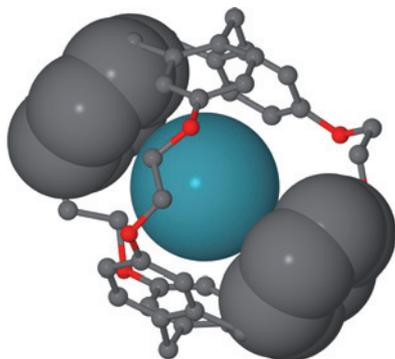


HOST-GUEST CHEMISTRY

Rounding up radon

Proc. Natl Acad. Sci. USA **108**, 10969–10973 (2011)



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All of the isotopes of radon are radioactive, which means that its chemistry has not been studied as widely as its smaller and more stable cousin, xenon. In particular, the supramolecular chemistry of xenon has been the focus of much research, and it is known that individual xenon atoms can bind inside hollow cage-like molecules with relatively high affinities. Although radon is incorporated in some crystal hydrates, until now there have been no examples of discrete molecular species to which it has been found to bind.

Based on their previous studies of xenon encapsulation by cryptophanes, a team led

by Ivan Dmochowski at the University of Pennsylvania and co-workers at the National Institute of Standards and Technology have now shown that radon can also be bound to this type of host molecule. They first used calorimetry experiments to show that a new water-soluble cryptophane with amino-functionalized side chains could bind to xenon with the highest reported association constant so far. Calorimetric measurements could not be used to study radon binding, however, because the quantity of radon available was limited (it is generated from the decay of radium chloride inside polymer capsules), so liquid scintillation counting had to be used instead.

Radon was found to bind inside the cryptophane slightly more strongly than xenon and this is explained by radon's larger size (it fills the cavity better than xenon) and more polarizable electron cloud. Both of these attributes are expected to increase the strength of van der Waals interactions between the noble-atom guest and cryptophane host. SC

TRANSITION STATE THEORY

Tunnelling control

Science **332**, 1300–1303 (2011)

Understanding what the products of a chemical reaction will be, or being able to rationalize what they were, is key in synthetic

chemistry and it is transition state theory that provides the foundation for this. Transition state theory considers a reaction as a voyage across a potential energy surface of peaks and troughs. Reactions require enough energy to surmount the peaks and can often get stuck in the troughs, giving rise to kinetic and thermodynamic reaction control. A kinetically controlled product will be preferred over a thermodynamic product if it has a lower peak to climb and does not have the energy to get out of the trough it later finds itself in.

Now, Peter Schreiner from Justus-Liebig University, Wesley Allen from the University of Georgia and colleagues have studied a unimolecular reaction that is neither thermodynamically or kinetically controlled; rather, it is tunnelling that governs its main product. Methylhydroxycarbene ($\text{H}_3\text{C}-\text{C}-\text{OH}$) was trapped in an inert matrix of argon at 11 K, which should prevent any reactions at all, by depriving it of the energy it needs to surmount the energy barriers to products. A reaction did occur, however, and the kinetic product (vinyl alcohol) expected by transition state theory was not observed. Methylhydroxycarbene instead isomerized to acetaldehyde through a migration of the hydrogen of the hydroxyl group.

Schreiner, Allen and colleagues used theory to discover that the reaction was in fact occurring through tunnelling, whereby

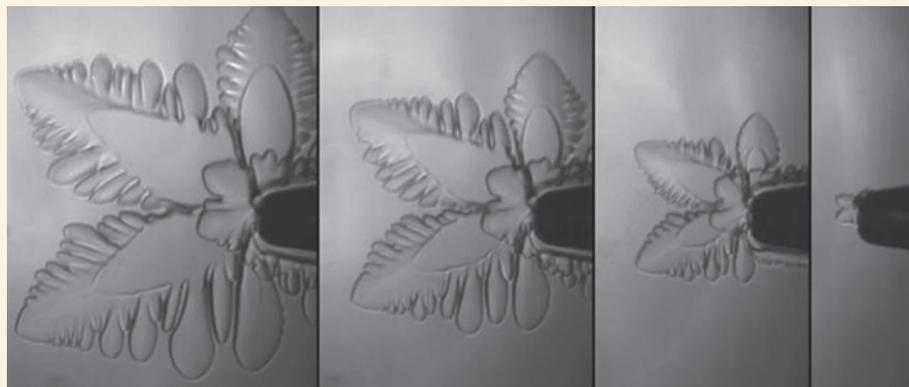
CRYSTAL GROWTH

Heavy ice patterns

J. Phys. Chem. B **115**, 8739–8745 (2011)

Ice crystals can adopt a wide variety of patterns, depending on their local environment during the nucleation and growth processes. Supercooled water has previously been shown to form dendritic crystals, whose early development involves the two basal planes of an initial disk-like crystal evolving asymmetrically and then subsequently acquiring a dendritic morphology.

Etsuro Yokoyama from Gakushuin University and co-workers at other institutions in Japan have now closely examined the growth mechanism. They avoided convection of water molecules around the dendritic tips by carrying out their observations under microgravity conditions at the International Space Station. The evolution of the ice crystals was studied using two chambers, one for nucleation and one for growth, and using D_2O instead of H_2O because it is more sensitive to temperature changes. Two factors are important — the



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velocity of the dendritic tips and the increasing thickness between the basal planes. The researchers measured both, over time, by using optical and interference imaging and combining these data computationally.

No growth of the basal faces was observed at very low supercooling. On increasing the temperature difference, the faces did grow,

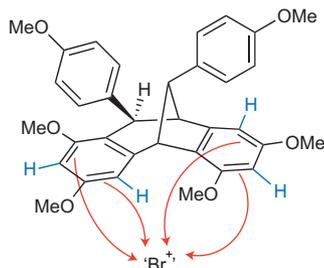
adopting different kinetics under different amounts of supercooling. Apart from at very low supercooling, the tip velocities were in good agreement with those predicted theoretically. These experiments show that the growth process of the basal faces has a significant influence on the tip velocities — larger than on the asymmetry of the disk. AP

the energy barrier is not overcome, but the migrating hydrogen quantum-mechanically burrows through the narrower energy barrier. Although hydrogen tunnelling is not new to chemists, it has never been seen to have such an influence on the outcome of a reaction. *GA*

NATURAL PRODUCT SYNTHESIS

Optimizing oligomers

Nature **474**, 461–466 (2011)



Resveratrol has been the subject of much attention because it is widely credited as being responsible for the so-called French paradox — a diet high in saturated fat accompanied by a low rate of coronary heart disease. This simple polyphenol is also the building block for several hundred oligomeric natural products. The formation of these oligomers can involve several different reaction pathways that — coupled with the various stereochemical possibilities — lead to structures with diverse architectures and biological activities. These compounds are, however, difficult to isolate from natural sources and, when synthesized, uncontrolled oligomerization is not an option on account of the variety of reaction pathways.

Building on their work to develop selective routes to dimeric structures from an alternate precursor (that is, not resveratrol itself), Scott Snyder and co-workers from Columbia University have reported a strategy for the selective synthesis of several trimeric and tetrameric oligomers. The strategy relies on the development of selective bromination reactions of two dimeric cores. In both cases, theory suggested that there was a not a significant difference in reactivity between possible bromination sites, but extensive experimentation eventually showed otherwise.

Routes to ampelopsin H and carasiphenol C required selective mono- and dibromination of a core with four (two pairs of equivalent) electrophilic sites. Related routes to ampelopsin G, carasiphenol B and vaticanol C required the more challenging task of selective bromination of a core featuring four distinct sites and even resulted in the development of a new electrophilic bromination reagent. The strategy should allow the optimization of biologically relevant properties in unnatural analogues of resveratrol oligomers. *SD*

PROTEIN NMR

Spectroscopy of sediment

Proc. Natl Acad. Sci. USA **108**, 10396–10399 (2011)

Nuclear magnetic resonance spectroscopy is the structural tool of choice for chemists of many different disciplines, who make use of its ability to probe the chemical environment of different atoms. As the molecules being studied increase in size, however, the resolution becomes worse and worse. For studying proteins, with molecular weights in the hundreds of thousands of Daltons, the technique is increasingly difficult. Using solid-state NMR to study crystalline proteins is one answer, but proteins are notoriously difficult to encourage into the crystalline state.

Now, Ivano Bertini, Claudio Luchinat and colleagues from the Universities of Florence and Munich have side-stepped the crystallization problem. They realized that solid-state NMR probes, which are commonly rotated at high speeds to enable ‘magic-angle spinning’ experiments, act like ultracentrifuges. This, they reasoned, could be used to spin proteins into a solid sediment that could be studied using solid-state NMR techniques. As a proof of principle, Bertini, Luchinat and colleagues studied a solution of apoferritin, a 480 kDa protein that is almost impossible to analyse using solution NMR, but which can be obtained in microcrystals for comparison.

The team observed no signal when the solution was stationary, but peaks began to emerge when the rotor was spun at 3 kHz. Between 6 and 8 kHz the resolution of the spectrum was almost as good as the one obtained from crystalline solid samples. Encouraged by this, they tried a complicated 2D experiment and the spectrum obtained from the sediment had resolution as good as the solid-state experiment. Bertini, Luchinat and colleagues hope that their simple method will allow a range of future uses: following structural changes after addition of reagents, for example, or studying larger biomolecules such as the ribosome or proteasome. *NW*

Written by Gavin Armstrong, Stuart Cantrill, Stephen Davey, Anne Pichon and Neil Withers.

Correction

In the Research Highlight ‘High-pressure materials: Diamonds are for aerogels’ (*Nature Chem.* **3**, 498; 2010), the reference DOI should have been ‘10.1073/pnas.1010600108’. This error was corrected online in the HTML and PDF versions on 23 June 2011.

blogroll

What’s in a name?

Those famous reactions that you might never have used, a chemical-free quest and an unpleasant organocatalyst.

Named reactions represent a fascinating subsection of chemistry, so we eagerly awaited the answers to Derek Lowe’s ‘Name Reactions You’ve Never Run’ blogpost (<http://go.nature.com/zTUwHt>). Lowe starts things off with the confession of a colleague who, despite years of experience, has never run a Diels–Alder reaction and continues with his own admission “I’ve never done a straight aldol condensation”, nor a Fischer indole synthesis. The comments thread was soon filled with people happily admitting which famous reactions have passed them by.

Who could fail to click on a blogpost with the title ‘Is earwax an organocatalyst?’ (<http://go.nature.com/UMNsvZ>). We certainly couldn’t and were rewarded with an informative post on the Chemistry Blog by Chemjobber, picking up on a Newsprints item by Steve Ritter in *Chemical and Engineering News* (**89**, 56; 2011). Way back in 1960 — in the days before blogs — budding chemist Charles Johnson discovered that his earwax accelerated the process of making colourful lake pigments. In his later life, as an undergraduate student, Johnson further found that earwax worked as a catalyst to make *trans*-stilbene, “although his professor didn’t seem impressed.” Chemjobber reminds us of Dylan Stiles’s blogpost on the now-defunct Tenderbutton in which he took a TLC of his earwax, which Chemjobber describes as “one of the initial triumphs of the chemblogosphere”. Who knew such an unpleasant substance was so interesting?

And finally... Mary Carmichael (http://twitter.com/mary_carmichael) got so fed up with seeing marketing spiel that uses the phrase ‘chemical-free’ to describe products that she started a blog, ‘F No, “Chemical Free!”’ (<http://fnochemicalfree.tumblr.com/>). Among the products named and shamed so far are “chemical free sunblock and bug spray” and even a chemistry set that offers “60 fun activities with no chemicals”. That doesn’t sound like much fun to us.