Abstractions

LAST AUTHOR

Materials made of nanometre-scale components have potential uses in a range of technologies, from batteries to aerospace. However, existing materials based on clay or carbon nanotubes have drawbacks. Striving to make use of an abundant and inexpensive starting material, Rod Ruoff of Northwestern University in Evanston, Illinois, and his colleagues found a way to transform graphite, allowing it to be split into individual sheets that can be stacked into a strong 'paper' (see page 457). *Nature* caught up with Ruoff to learn more about it.

Has graphite-based paper long been a goal?

For me, yes. No one has yet separated pieces of graphite into single layers on a large scale. Graphite is stiff in two of three dimensions, but has low overall strength because the individual crystals are only 'butted' against each other, not knitted together at their edges. Scientists and engineers would like to be able to separate and chemically manipulate individual graphite layers to make stiff, strong composites. Graphite also has other useful properties — for example, it is conductive.

What inspired this approach?

The abalone shell. This contains layers of mineral platelets held together by a protein 'glue'. I thought if we could disassemble graphite's layers and reassemble them similarly to this shell, we might get good stiffness but also high strength.

What was the key step?

The convertion of graphite to graphite oxide. This maintained the layered structure but altered the layers' carbon skeletons to be hydrophilic and so disperse well in water, yielding individual sheets of graphene oxide.

How does your method interlock the sheets?

We aren't sure. This is still discovery-based science. Further experiments are needed to determine the process of layer building, and we hope that they might also lead to better control of the stacking.

What is the biggest challenge for designing nanomaterials?

An exciting challenge is to achieve control from the atomic through to the macro scale so that we know the location of every atom. Then, we could 'dial in' a much wider range of useful properties.

Where might this material be used?

In aerospace and in anything needing strong, lightweight materials. We think there are exciting opportunities in energy storage, such as in batteries and supercapacitors. It might even be used in structural components of windmill turbine blades. ■

MAKING THE PAPER

Lawrence Steinman

How an eye lens protein protects the brain from disease.

For Lawrence Steinman, research into the role of an eye lens protein in the neurological disease multiple sclerosis (MS) drew a surprising link to a formative research experience more than 35 years earlier. The Stanford University neurologist's recent work establishes the protein αB-crystallin (CRYAB) as a central agent in controlling inflammation and programmed cell death in the brain (see page 474). It also tied in to a long-held fascination, kindled in his student days, in the visual system.

Crystallins are well known as the main refractive proteins in vertebrate eye lenses, where they contribute both physical and optical characteristics. In 1995, Dutch biologist Johannes van Noort and his colleagues discovered that CRYAB is also highly expressed — and highly immunogenic — in the brains of MS patients (J. M. van Noort *et al. Nature* **375,** 798–801; 1995).

When Steinman read this work, he recalls, "My first thought was, 'What? This must have fallen off the shelf into the soup, because how could you have CRYAB in the brain?'". Other researchers ran a handful of experiments investigating whether the lens protein contributes to the pathology of MS, but these were inconclusive. Steinman's own investigations into CRYAB's role in the disease didn't begin until 2001. The delay, he says, occurred for a very simple reason — it took him until then to think of the right set of experiments.

In 2001, his team showed that the gene for CRYAB tops the list of genes transcribed in the brains of people with MS, but not in healthy subjects or those with other neurological diseases. The researchers knocked out the gene encoding Cryab in mice, then induced the animals with a model of MS known as experimental autoimmune encephalomyelitis. "I didn't really know what to expect," Steinman recalls, "but when I saw that the experimental disease was actually worse without Cryab, I made the operating hypothesis that CRYAB must be doing something that protects the brain in MS." Steinman's team has since shown that CRYAB tones down many inflammatory pathways and helps prevent programmed cell death, both of which are involved in the autoimmune processes thought to underlie MS.

This discovery finally made sense of the 'eye' protein's presence in the brain. And although vision scientists knew that CRYAB could inhibit protein crosslinking, the full range of its roles in eye health — and as a possible therapeutic agent in diseases throughout the body — is just now coming to light. CRYAB may even have potential in vaccine development, given that some microbes, for example those that cause tuberculosis, have evolved crystallins of their own to short-circuit their hosts' immune responses.

Aside from the biological possibilities, Steinman relishes the personal connections that have arisen from this work. One is with van Noort, whose original 1995 study Steinman calls "one of the coolest experiments done in MS". The two have become collaborators, with van Noort providing patient data for the current study.

Even sweeter, says Steinman, are the ties to his past. As a student at Harvard in 1970, he worked for Torsten Wiesel, who won a Nobel prize in 1981 for his research on the visual system. "Even though I went on to study brain diseases, I remained fascinated by visual science," he says. "With crystallin, my early interest in vision has returned to intersect with my current work in a way that is ironic, strange and delightful." ■

FROM THE BLOGOSPHERE

Peer-to-Peer, at http://tinyurl.com/2q8myv, highlights a post on the pseudonymous FemaleScienceProfessor blog about the benefits (or lack thereof) of reviewing reviewer performance. FemaleScienceProfessor is also an editor for a journal. She writes: "I did a quick, statistically invalid analysis of the reviewer data for the past year to see whether the time it took a reviewer to complete the review was random or correlated with seniority. The quickest reviewing groups are the early-career and retired scientists." More analysis and the reactions of some of her readers are provided at FemaleScienceProfessor's blog post and comments section.

At the Nature journals, we do not publish reviewer statistics of this type, nor do we set out to capture information about factors such as reviewers' gender or seniority level. Is there interest from our peer-reviewers and authors to know these sorts of statistics? Is the quickest review necessarily the 'best' review? What would be appropriate metrics? You can provide your thoughts by going to the Peer-to-Peer URL provided above. ■

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