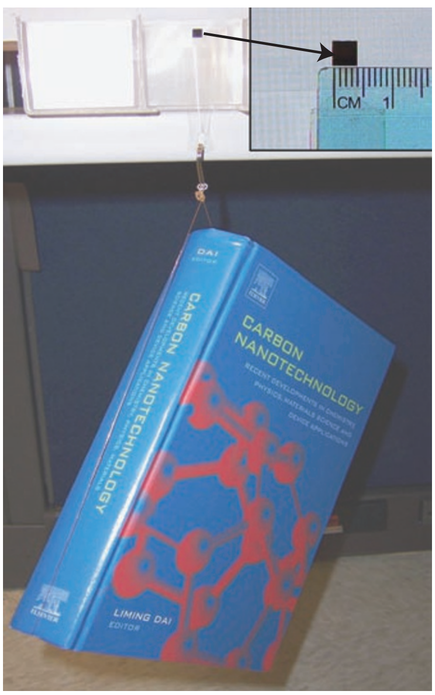
with a range of proteins to form a 'protein corona', which is thought to affect the way nanoparticles interact with biological systems. Researchers at University College Dublin now report that nanoparticle size and surface properties can determine the type of protein that forms the corona.

Kenneth Dawson and colleagues incubated polystyrene nanoparticles of various size and charge in human plasma, and analysed the proteins that bound to the surface. They first separated the proteins using gel electrophoresis and then determined their identity by mass spectrometry, which fragmented the proteins into their peptide components. The particles displayed a size- and charge-dependence when the number of overlapping proteins was compared. Several important proteins were identified as adsorbing on the particle surfaces. These included immunoglobulins (involved in immune responses), apolipoproteins (involved in the transport of lipids and cholesterol in the blood), and several proteins that are involved in blood coagulation.

The proteins investigated in this study suggest that, depending on size and charge, a range of proteins with distinct biological roles can form part of the corona. Whether these proteins are presented in a way that can affect biological processes remains unknown.

NANOTUBES

Echoes of geckos



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Science **322,** 238–242 (2008)

Gecko lizards seem to defy gravity by climbing vertical surfaces. Only recently it was discovered that geckos acquire their sticking ability from microscopic hairs, called setae, on their feet. Now scientists in the US have made a material with ten times the adhesive strength of gecko feet, by using carbon nanotubes to mimic the setae structure.

The material, developed by Liming Dai at the University of Dayton, Zhong Lin Wang at the Georgia Institute of Technology and colleagues comprises over 10 billion carbon nanotubes per square centimetre aligned vertically on a silicon wafer. The nanotubes all have curly, entangled tops that enhance the attractive forces between the nanotubes and the surface.

A tiny patch of the material, 4 mm by 4 mm in size, was stuck to a glass wall and used to support weights of well over a kilogram. The patch retained its adhesive strength even after being attached and detached several times.

Most importantly, the adhesion is much stronger parallel to the surface than when a force is applied perpendicularly. This means the material mimics the gecko's best secret — it can easily be unstuck by pulling away from the surface.

NANOCRYSTALS

Vibration qualification

Proc. Natl Acad. Sci. **105,** 14784–14789 (2008)

Metal nanocrystals with different degrees of atomic order, or crystallinity, have different electrical, mechanical and chemical properties. Marie-Paule Pileni at Université Pierre et Marie Curie in Paris and co-workers have now discovered a new way to measure crystallinity — using Raman scattering to monitor changes in the way the crystals vibrate.

The researchers prepared gold nanocrystals and separated them into batches of similar size. They found that smaller nanocrystals tended to be single-domain crystals with one clear ordered structure throughout, whereas larger ones were polycrystalline, comprising clumps of different crystal orientations.

Raman spectroscopy showed that both the single and polycrystalline nanocrystals vibrate with the same displacements, but do so at different frequencies. In particular, the atomic ordering in single-domain nanocrystals changes their elastic properties, resulting in two separate vibrational modes that can be seen as two clear peaks in the Raman spectrum. Polycrystalline nanocrystals produce only one broad peak because they are a blend of different structures.

The authors suggest that Raman scattering can offer a simple alternative to electron microscopy for characterizing crystallinity in order to select specific nanocrystals.

TOP DOWN BOTTOM UP

Working in harmony

Researchers across Europe have collaborated to identify the 'music' of different types of nanoparticles.

George Fytas first became interested in the behaviour of acoustic waves in nanomaterials during a seminar on photonic materials by Ned Thomas of Massachusetts Institute of Technology at the Max Planck Institute for Polymer Research (MPIP) in Mainz. Fytas and Thomas subsequently started a trans-Atlantic collaboration, but Fytas also began multidisciplinary projects with his MPIP colleague Ulrich Jonas and Goetz Hellmann, a chemist at the Deutsches Kunststoff-Institut in Darmstadt.

In the latest project, Fytas, Jonas, Hellmann and their students have teamed up with Rebecca Sainidou, a theoretical physicist at Instituto de Óptica in Madrid, to explore the mechanical properties of nanoparticles that have a silica core inside a polymer shell, and of hollow polymer spheres. In particular, they have used Brillouin light-scattering and numerical calculations to show how the vibrational modes of these particles — or the 'music' — depend on the size of the particles (*Nano Lett.* **8,** 3194–3199; 2008).

"Finding a common language in interdisciplinary collaborations is not easy," says Fytas, "and it is important to always keep the interest and motivation high. The reward is we can say we have now 'heard' the music of submicron core–shell particles. But more rewarding was the fruitful collaboration between the three PhD students involved — Peter Spahn, Markus Retsch and Tim Still."

What advice does he have for others? "First, a good research problem with broad interest should be formulated," he advises. "Then find good partners with expertise truly different from yours." It is also important, stresses Fytas, that the partners find the problem to be equally fascinating. "The presumption that colleagues of different backgrounds will understand you immediately is risky," he says. "You must be convinced that direct and honest communication of problems, findings or mistakes is common among all members."

The definitive versions of these Research Highlights first appeared on the *Nature Nanotechnology* website, along with other articles that will not appear in print. If citing these articles, please refer to the web version.