MAGNETIC NANOPARTICLES

Safe for sperm

Langmuir **22**, 9480–9482 (2006)

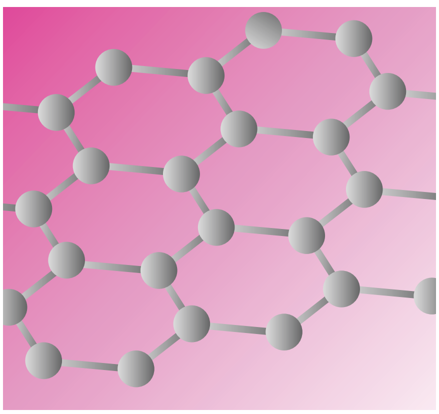
The low toxicity and magnetic properties of iron oxide nanoparticles have led to their use in various biomedical and diagnostic applications such as cell labelling and targeting, drug delivery and tissue repair. However, their affect on sperm cells has never been investigated. Researchers at the Bar-Illan University in Israel now show that loading sperm cells with magnetic nanoparticles does not affect the way they move or their ability to fertilize an egg.

Aharon Gedanken and co-workers incubated polyvinyl alcohol-coated iron oxide nanoparticles with bovine sperm cells for different periods of time. This coating, which protected the nanoparticles from oxidation, improved the particle uptake by the cells. Nearly half of the nanoparticles that entered the sperm were bound to various parts of the cell, with the highest density seen in the mitochondria, where energy is generated.

Nanoparticle-treated sperm was able to fertilize eggs with the same success rate as untreated sperm. Consequently, the presence of iron nanoparticles has no effect on the sperm's motility or its ability to undergo the acrosome reaction — the process in which it fuses with an egg. In the future, magnetic nanoparticles could be used to transport drugs into sperm cells.

GRAPHENE

Through thick and thin



Phys. Rev. Lett. **97,** 187401 (2006)

Graphene — a single layer of graphite — is the structural unit that wraps to form carbon nanotubes and fullerenes. Because the electron conduction is nearly collision free, even at room temperature, this atomically thin carbon sheet is also interesting in its own right. Only recently have researchers figured out how to cleave a layer or layers of graphene from graphite, and even then, atomic force microscopy has been the only reliable method to determine the number of layers.

Now, Andrea Ferrari of Cambridge University and colleagues show that Raman spectroscopy provides a unique fingerprint of the number of graphene layers. Raman spectroscopy measures the energy shift of light in a solid that results from interactions with atomic vibrations, electrons or a combination of the two. In this study, it is shown that a single, strong peak in the spectrum of graphene — the so-called '2D' peak — splits and shifts to a higher energy when there is more than one layer.

The fact that single and multiple layers of graphene have distinct Raman spectra reflects the difference in the electronic properties of a two-dimensional layer of carbon and three-dimensional graphite. This crossover appears to occur around five layers, when the spectrum of several layers of graphene and graphite become indistinguishable.

NANOWIRES

Pores for thought

J. Am. Chem. Soc. **128,** 14258–14259 (2006)

The unique electrochemical properties of cobalt oxide make it an important material for a range of applications. Now, researchers at Ohio State University in the USA have shown how hollow nanowires made of porous Co_3O_4 can be grown directly onto conducting substrates.

Yiying Wu and co-workers made nanowires that contained both cobalt hydroxide and Co_3O_4 by immersing the substrate in a hot solution of cobalt nitrate and concentrated ammonia. These nanowires were then converted into pure single-crystal Co_3O_4 nanowires by heating them. Scanning electron microscope images showed that the nanowires were hollow, approximately 500 nm in diameter and up to 15 μm long. They were also porous, with pore sizes of 3–4 nm. The nanowires were grown on a variety of substrates including silicon, transparent conducting glass and copper foil. Furthermore, it was possible to pattern the substrate, covering parts of it with gold and therefore preventing nanowire formation in these areas.

The ability to make good electrical contact with conducting substrates, combined with a high surface area, means that the nanowires could prove useful for applications such as lithium-ion batteries, gas sensing and electrochromic devices.

TOP DOWN BOTTOM UP

Organics take control

Molecules and silicon devices can work together, as can chemists and engineers.

Building a molecular computer is a challenge that calls for expertise in a variety of different disciplines. James Tour, a chemist at Rice University in Texas, was already collaborating with John Reif, a computer scientist at North Carolina State University, on such a project when he realized that he needed help from someone who knew about the packaging and fabricating of electronic devices. Reif put Tour in contact with Paul Franzon, an electrical engineer at North Carolina, and they have now shown that organic molecules can control the electronic characteristics of silicon field-effect transistors (*J. Am. Chem. Soc.* **128,** 14537–14541).

Tour, Franzon and co-workers fabricated a pseudo-MOSFET — a form of field-effect transistor that serves as a proof-of-concept device — that consisted of boron-doped source and drain electrodes with a channel in between. After Franzon prepared the devices, Tour grafted organic molecules with different electronic properties onto the channel region of the transistors. Electron-poor molecules increased the conductance of the channel, whereas electron-rich molecules had the opposite effect. Grafting molecules in this way is similar to doping, which is central to all semiconductor devices, and this approach could prove to be useful when electronic devices become so small that the traditional methods of doping no longer work.

What has Tour learned from the collaboration? "Be prepared to learn a new language and explain yourself very simply," he says. "Even simple terms like 'hole mobility' can cause a synthetic chemist to scratch his head, but once he realizes that we are simply talking about the flow of cations, then discussions become easy." The two sides also had different approaches to laboratory chemicals. "Engineers are sometimes skittish about using solvents like dichloromethane," says Tour, "but they will use terribly dangerous compounds such as silane without batting an eye".

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.