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The light stuff

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Many hands are making light work better by using carbon nanotubes. Optical and photonic devices for industry, medicine and consumers may be improved if the new technology can be perfected.

Dow Corning and Advance Nanotech are among the companies supporting this advanced work. They are funding research at Cambridge University, where scientists expect to demonstrate a portable fibre-laser containing a nanotube mode-lock within a year.

'The fibre-laser may not ultimately be the biggest market application for our technology, but it's where there are existing technologies with which ours can be compared,' said Dr Andrea Ferrari of the university's Centre for Advanced Photonics and Electronics (CAPE).

The mode-lock in a laser acts like a sieve. It only allows pulses of a specified wavelength and intensity to pass through. Most are made using molecular epitaxy, but carbon nanotubes offer a new approach. Nanotubes can be used as semi-conductors and their band-gap for absorption depends on their diameter. Infrared light is absorbed by relatively large diameter nanotubes, ultraviolet and visible light by small ones. So, nanotubes of the right dimensions can be used as a fibre-laser mode-lock, screening out unwanted pulses.

The concept has been demonstrated by CAPE scientists with a laboratory experiment that generated pulses of 600 femtoseconds. The difficulty lies in embedding the optimum number of nanotubes in the material most suitable for industrial-scale application. If there are too many nanotubes in the transparent material they would block too much light; too few and unwanted pulses get through.

To get the balance right, researchers have funding from Dow Corning and Advance Nanotech, and a grant from the EPSRC. They will look at proprietary polymers to see which has the best properties. 'We want to make a polymer- composite that is easy to handle and robust,' said Ferrari. 'The plastic film must be completely transparent so that it plays no active role whatsoever in the mode-locker.'

Research already undertaken reveals that the required proportion of nanotubes to polymer is small, less than one per cent by weight. 'This means that from one or two milligrammes of carbon nanotubes we could make 200-300 mode-lockers,' said Ferrari. 'The trick is to minimise the losses, to decrease scattering and decrease the

thickness of the polymer film. I'm pretty sure we can do it.'

The aim is to have a portable demonstrator fibre-laser to show industry next summer, in the hope it will convince others that using nanotubes will be more attractive than molecular epitaxy for making mode-lockers. 'The epitaxy equipment is big and is good for making mode-lockers of one wavelength. Also, there are certain wavelengths it can't address,' said Ferrari. He believes the nanotube approach will reduce some of the problems.

Nanotube-based photonic devices are expected to find a wide range of applications, not only in optical communications but also in bio-medical instruments, chemical analysis, time resolved spectroscopy, electro-optical sampling, microscopy and surgery.

Advance Nanotech is supporting several research projects at Cambridge, including others at CAPE. The company describes its misssion as commercialising disruptive nanotechnologies, to 'build businesses that transform academic nanotechnology platforms into nano-enabled products'.

The alliance with university research is key to success, the company believes. In August, the New York based company announced it would be focusing on the use of nanotechnology for security and display applications, both of which are sectors to which this particular Cambridge project could contribute. It is so close to the research that it has one executive posted permanently at CAPE.

Thomas Finn, chief financial officer at Advance Nanotech, has made it clear that working with universities is vital.

'Advance Nanotech has made great progress over the last two years in advancing potentially game-changing nanotechnologies. Our partnerships with leading universities and governments have laid the foundation for success,' he said.

'The company is listening to the market demands for nanotechnology, and is taking the appropriate steps to mature into an operating company that can meet those specific demands. This enables us to leverage our university programs to add depth and a product pipe-line to our "anchor" investments and, in doing so, create operating divisions with substantial competitive advantage,' he added.

It is a relationship that appears to benefit both sides and affirms the more conventional use of the proverb that many hands make light work.

'Working with Advance Nanotech gives us access to talent and resources beyond the university walls,' said Prof Bill Milne, director of CAPE. 'Its partnerships with other research facilities and manufacturers enable us to draw on the expertise of the best minds in nanotechnology from around the world.'

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