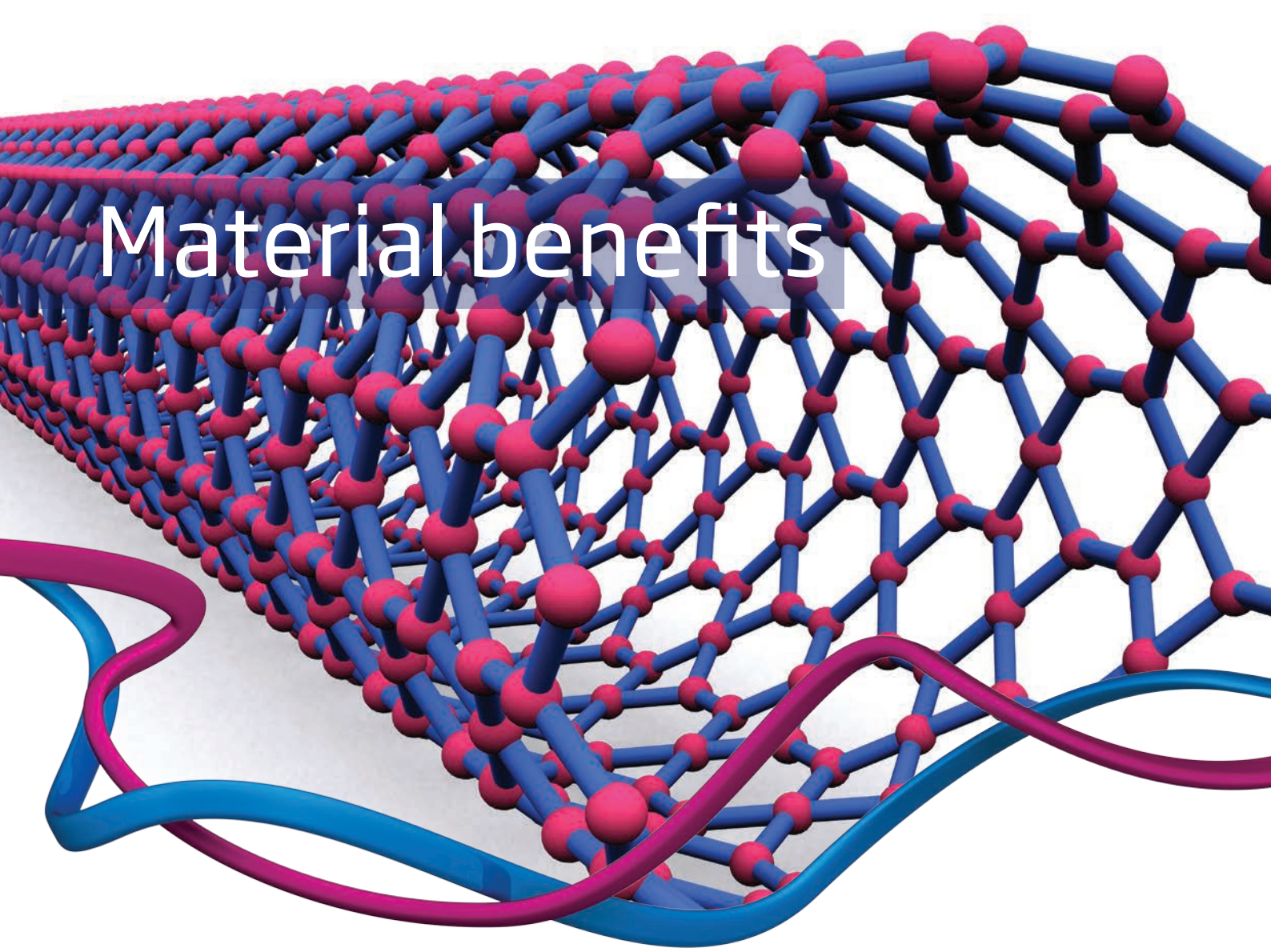
Material benefits



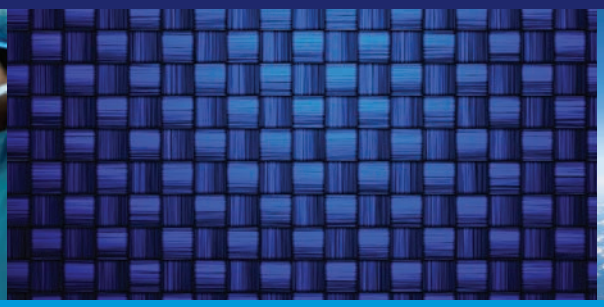
Professor Ian Kinloch aims to develop practical methods of manufacturing and using carbon nanomaterials. Concepts that he pioneered in carbon nanotubes are now being applied to other materials such as graphene.

ROYAL ACADEMY OF **ENGINEERING**

Research area

Ian Kinloch became Professor of Materials Science at the University of Manchester in 2012. He leads the nanomaterials group and works with other departments within the university and with researchers at other universities and in industry. From doctoral studies and postdoctoral work at the University of Cambridge, he developed methods for the large-scale production of carbon nanotubes which have been commercialised through the speciality chemicals company that sponsored his studies and through a spin-out company based in Cambridge.

His current research applies the methods developed for carbon nanotubes to investigate routes to manufacture graphene on a commercial scale; he is also researching the rheological properties of graphene – how it might be distributed within a polymer matrix – and methods of developing composite materials that could take advantage of graphene's properties. Professor Kinloch takes what he terms a 'holistic' approach in developing the materials, the processes to manufacture them, and the application markets, all in parallel. "This assures potential customers that the product will be available in the right quantities when they need it, and assures suppliers that there are markets for the materials and products that they are gearing up to produce", he said.


Academy support

Ian Kinloch held a Royal Academy of Engineering/EPSRC Research Fellowship, initially at Cambridge and later at Manchester. The Fellowship enabled him to progress his ideas about commercial-scale production of carbon nanotubes and to build his own career and, at Manchester, his own laboratory.

He said, "One of the beauties of the Royal Academy support is that it is an individual prize, and gives a huge amount of flexibility. It takes the brightest and the best people who are going to be the future engineering leaders and gives them a completely open field in terms of what they research. The focus of the research is of your own choosing, and the Academy enables you to progress your career by developing your research topics and by providing the flexibility to move between institutions. Its support for me included a wonderful mentor in Professor Dame Julia King DBE FREng, and I appreciated the low admin load as well. But mostly it really gave me the chance to develop my own independent research career."

"The Royal Academy of Engineering support for research is fundamental to enable younger engineers to develop their ideas and to broaden their independent careers. I became a professor at the age of 36: without the Academy I could never have achieved that."

Professor Ian Kinloch

Other support

Including the Academy's support, Ian Kinloch's research has attracted funding totalling more than £4 million, with contributions from the Royal Society, the EPSRC, the BBSRC and industry. He currently receives funding from the EPSRC, and aims to transfer the work that he pioneered with carbon nanotubes to graphene.

Research impact

Ian Kinloch's research has been based in commercial realities throughout his career, and has implications for important industries such as aerospace, automotive and biomedical engineering. His postdoctoral research at Cambridge was sponsored by Thomas Swan and Co and is the basis of the commercial carbon nanotubes production technology that Swan sells under the Elicarb name. Further research led to the invention of a production method for 'nanotube ropes' that is being commercialised through a Cambridge University spin-out company called Q-Flo. In parallel, Professor Kinloch worked on the rheology and dispersion of nanotubes, refining their behaviour and developing processes that will enable them to be incorporated into polymers in ways similar to those already used with other kinds of fibres in composite materials.

The carbon nanotube work is now at the point where it is ready for exploitation by engineers in real-world applications, and Professor Kinloch's emphasis has shifted to expanding the methodologies developed for carbon nanotubes into graphene, a material for which colleagues at Manchester University won the 2010 Nobel Prize in Physics.

Applications for such materials will be in areas such as aerospace, where a graphene-based composite should significantly outperform current carbon fibre-based composites for use in, for example, wing structures and biomedical engineering applications as scaffolds for reconstructive surgery. A lot of current work, however, is focused on energy storage, where the large surface area, low density and chemical stability of graphene offer huge potential for electrodes in batteries, solar cells and fuel cells. The research in this area is also developing fundamental knowledge of electrochemistry that feeds through to work in other areas such as lithium-ion batteries and supercapacitors.

Future challenges

New materials inevitably take a long time to find applications, but the basic challenge is to produce them on a commercial scale and to incorporate them into formulations such as composites that make their adoption in products practical. Professor Kinloch's work has helped to bring carbon nanotubes to the point where exploitation is now possible, but with graphene development there is greater urgency and a national desire to ensure that the UK is well-placed to benefit from the commercial exploitation. The challenge is to transfer technology and at the same time to engage businesses that will take the next steps to develop viable products. Through the National Graphene Institute, Professor Kinloch and his colleagues are talking directly to companies, using Knowledge Transfer Networks and other means to drive UK, European and worldwide take-up.

Biography/ Career Progression

1997-2001 PhD, *Carbon nanotubes: production and dispersion*, Department of Materials Science and Metallurgy, University of Cambridge

2001-2004 Research Associate, University of Cambridge

2004-2009 Royal Academy of Engineering/EPSRC Research Fellow

2009-2010 Lecturer, School of Materials, University of Manchester

2010-2012 Senior Lecturer, School of Materials, University of Manchester

2011 to Present Challenging Engineering EPSRC Fellowship, University of Manchester

2012 to Present Professor of Materials Science, University of Manchester