10.1098/rsta.2004.1453

Preface

Published online 14 September 2004

Carbon-based materials play a major role in today's science and technology. Carbon is a very versatile element, which can crystallize in the form of diamond or graphite. Great excitement has followed the discovery of new forms of carbon, including fullerenes and nanotubes, and this has fuelled an enormous amount of research in the ever-growing field of nanotechnology. Potential applications are in field emission displays, microwave amplifiers, transistors, supercapacitors, structural and conductive composites, hydrogen storage, etc. There are also many non-crystalline carbons, known as amorphous carbons and nanostructured carbons (mixture of amorphous and graphitic carbon, nanotubes and fullerenes). Diamond-like carbons, being a key element in numerous everyday applications, play an important role in the information technology, telecommunications and automotive market. Diamond itself has great potential as a wide-band-gap semiconductor both as a bulk material and as nano-diamond, which is highly promising for micro-electromechanical systems. Polyconjugated polymers have a primary scientific and industrial interest: they can be extremely good conductors and they can be doped, which is the basis for the growing plastics-based electronics technology.

A vast number of publications and reviews covering applications and growth recipes already exist. What is often forgotten is that a key part of the research is the identification and characterization of these materials, both at the laboratory and the mass-production scale. To be appealing, a characterization tool must be non-destructive, fast, with high resolution and give the maximum amount of structural and electronic information. Raman spectroscopy provides all of these. It is the backbone of research in such diverse fields as physics, engineering, chemistry and biology. Indeed, most of the papers published every year on carbon materials have at least one Raman spectrum in them.

What is most amazing is that the Raman spectra of all carbon systems show only a few prominent features, no matter the final structure, be it a conjugated polymer or a fullerene. The spectra appear deceptively simple: just a couple of very intense bands in the 1000–2000 cm^{-1} region and a few other modulations. Still, their shapes, intensities and positions allow researchers to distinguish a hard amorphous carbon from a metallic nanotube. The low-frequency acoustic vibrations allow the direct measurement of the elastic properties of these materials.

Raman spectroscopy in carbons often seems to be an assembly of watertight compartments of growing dimension and complexity, steadily enlarged by the continuing development of carbon materials research and applications. This is very detrimental and often confuses non-experts wishing to enter the field, since new results are rapidly replacing long-standing ideas. On the contrary, the Raman spectra of these materials are branches of the same tree. In this Theme Issue the leading experts on Raman spectroscopy of carbon systems provide the first comprehensive state-of-the-art review of this fast evolving field of research. Both the basic concepts and the

One contribution of 13 to a Theme 'Raman spectroscopy in carbons: from nanotubes to diamond'.

practical applications are covered. The accepted results and the still existing controversies are highlighted. This is an essential guide for anybody interested in carbon science and technology.

Andrea C. Ferrari
John Robertson
University of Cambridge