Reg. No: 2015/19/P/ST5/03799; Principal Investigator: dr Dawid Witold Janas

Introduction

We live in the times, when energy demand is growing at such a fast pace that it will not be long before we encounter a huge crisis unless new discoveries come to light to avert it. What we need is a new generation of electrical conductors, which would be more efficient, ecologically-friendly and sustainable. A recently discovered form of carbon called carbon nanotubes (see below) seems as one of the most viable candidates, but first we need to focus more on basic research to really understand the science behind carbon nanotubes' remarkable properties. Only when we gain thorough understanding of their electrical properties, we will be able to make a difference to the world and truly improve the performance of devices surrounding us.

What are carbon nanotubes?

Carbon nanotubes are a new form of carbon, in which carbon atoms form cylindrical nanostructures (Fig. 1b,c). These individual tiny carbon tubules constrain the transport of electrons to movement along the axis, what helps them outperform the best classical conductors such as silver, copper and aluminum on the nanoscale. Moreover, carbon nanotubes are very strong, light and are relatively easy to make from renewable resources.

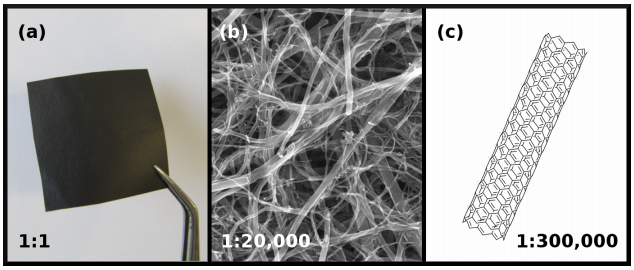

Fig.1. (a) carbon nanotube film, (b) carbon nanotube material microstructure, (c) individual carbon nanotube.

What are the problems?

From a certain angle, carbon nanotubes are not a material, but a family of materials, each of which has got different properties depending how these carbon cylinders are "rolled up" from a sheet of carbon atoms. They can be metallic and conduct electricity like almost nothing else on Earth or they present semi-conductive behavior, which also has its merits, but it is a serious problem when high conductivity is sought for. Many more interesting attributes are envisioned to be highly dependent on the arrangement of carbon atoms within a nanotube, but accurate basic research has not been yet possible due to two main reasons:

- synthesis of carbon nanotubes is to a large extent indiscriminate and one often ends up with a mixture of tens of different nanotube types, what does not allow for proper research of phenomena taking place,
- even if the material is enriched during or after the synthesis with a particular nanotube type, there is not a way to form them into macroscopic assemblies without contamination, what is often paramount for taking the measurement.

How and why to make it happen?

Whilst at the University of Cambridge, I have developed a first-of-its-kind method which enables manufacture of free-standing carbon nanotube films of a predetermined nanotube composition (Fig. 1a). That finally allows for research on the influence of the way nanotubes are "rolled up" on their properties. We could start to understand how these members of carbon nanotube family behave and take first ever measurements, which have not been practically possible before in the case of individual nanotubes of particular type. Such detailed study would bring science and society a leap closer to unraveling the hidden mysteries of the nanoscale. Most importantly, such basic research could one day help to bring these science phenomena home in the form of a high-performance, energy-wise product. Whether this would exploit the ability of nanotubes to create electricity from waste heat, or create a much more ecologically-friendly device, mankind would live in a more sustainable place thanks to the greater understanding of the universe.