Macroscopic fibres of carbon nanotube intercalation compounds

Juan J. Vilatela[1]

[1]Institute IMDEA Materials [Madrid] (IMDEA) – Eric Kandel 2, Tecnogetafe 28906 Getafe Madrid, Spain

This presentation describes progress on the synthesis and study of continuous fibres of carbon nanotube intercalation compounds (CNTIC). They consist of macroscopic, continuous fibres of aligned carbon nanotubes with intercalated species ordered between the CNTs, forming long-range domains of periodic intercalation of FeCl3 or Br, respectively.1,2 The first part focuses on the determination of their structure through direct imaging by HRTEM and 2-dimensional X-ray (wide-angle X-ray scattering), as well as DFT simulations. This analysis shows the importance of CNT polydisperisity and bundling to form CNTICs, and the lack of commensurability between the graphitic surfaces and the intercalate lattice. The introduction of either of these intercalants involves electron transfer from the CNTs to the intercalant, observed through various spectroscopic methods. As a consequence of intercalation the bulk fibre electrical conductivity increases by up to an order of magnitude, approaching the level of copper or aluminium on a mass basis. Through low-temperature transport measurements in the longitudinal and transverse directions, we show that the intercalate reduces the resistance associated with transport between adjacent CNTs, rather than exclusively acting as a dopant that increases conductance of individual CNTs. Finally, this work demonstrates that by preserving the separation between CNTs, intercalation of small species retains the exceptional mechanical properties of the CNT fibre host.3 The combined tensile strength above 2.46 GPa, conductivity of 10.68 MS/m and density of 2.34 g/cm3, makes intercalated CNT fibres attractive lightweight conductors with combined properties superior to metals and graphite intercalation compounds.

References

Macroscopic yarns of FeCl3-intercalated collapsed carbon nanotubes with high doping and stability. Carbon 173, 311-321, 2021.

Continuous intercalation compound fibers of bromine wires and aligned CNTs for highperformance conductors. Carbon 204, 211-218, 2023.

• Ultrahigh strength, modulus, and conductivity of graphitic fibers by macromolecular coalescence. Science Advances 8 (16), 2022. DOI: 10.1126/sciadv.abn0939