Ion-irradiated carbon nanotube networks: correlated changes in conduction and other properties

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Thin transparent SWNT networks show a conductance that varies with gate voltage and follows variable-range hopping behaviour, and is strongly suppressed by irradiation with ions [1]. As the thickness of the SWNT networks increases, however, the conductance becomes metallic: it is still relatively large in the zero-temperature limit and can be modelled by metallic conduction interrupted by barriers through which conduction is by fluctuation-assisted tunnelling [2,3]. Surprisingly, ion irradiation usually causes an increase in conductivity at low doses before the expected decrease dominates. Even more surprisingly, despite the different origins of the G, D and D* Raman modes, there is a remarkable correlation between their frequency shifts and changes in the conductivity and Young's modulus [4]. On ion irradiation, all these properties show similar peaks as a function of irradiation dose. On acceptor doping that increases conductivity, increases are also observed in the Raman mode frequencies that are closely analogous to the irradiation effects. We discuss the most likely reasons for the correlations between the changes in these properties, including a discussion of the conduction mechanisms involved [2] and the effects of thermal annealing due to irradiation [1].

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