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Carbon Nanotubes and graphenes: nanomaterials and nanodevices

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Summary

Some of our recent experimental works on carbon nanotube and graphenes are presented in this work. There are mainly three parts, which are explained in more details as the followings:

1. Single-walled carbon nanotube crystal: a new condensed form of SWNTs- crystal of SWNTs is obtained by using a series of diamond wire drawing dies. X-ray experiment indicates that the SWNTs arrange in a triangular lattice with a constant of 19.6 angstrom and the properties of SWNT crystal are studied.

2. SWNT energy conversion devices and self-powered system: We show that the water inside SWNT can be driven to flow by the applied electric field, acting as a "motor", where the electrical energy partially converts into flowing energy; and the flowing water conversely generates an electromotive force along the other part of nanotube, just like a "generator". Meanwhile, ethanol flowing outside the channels among SWNTs in a rope of SWNTS is demonstrated to harvest surface energy of ethanol and acts as a surface energy generator (SEG). The SEG can drive thermistors in a self-powered system. Meanwhile, the performance (the inducing rate of Voc, the value of Voc and output power) can be significantly enhanced by Marangoni effect. These SEGs show the advantages of smaller inner resistance, no moving parts and without application of an obvious external force.

3. Size effect and edge state in graphenes: We report the layer number-dependent morphologies of metal on n-layer graphene, which can be well explained by size effect of grapheme. Meanwhile, when ferromagnetic metals (Fe, Co and Ni) are thermally evaporated onto n-layer graphenes and graphite, a metal nanowire and adjacent nanogaps can be found along the edges regardless of its zigzag or armchair structure. Similar features can also be observed for paramagnetic metals, such as Mn, Al and Pd. Metal nanowires and adjacent nanogaps can not be found for diamagnetic metals (Au and Ag). An external magnetic field during the evaporation of metals can make these unique features disappear for ferromagnetic and paramagnetic metal; and the morphologies of diamagnetic metal do not change after the application of an external magnetic field. We discuss the possible reasons for these novel and interesting results, which include one dimensional ferromagnets along the edge.