A Chirality Selective Growth of Carbon Nanotubes via Twisted Graphene Nanoribbons

Hong En Lim[1], Yasumitsu Miyata[1], Ryo Kitaura[1], Yoshifumi Nishimura[1], Yoshio Nishimoto[1], Stephan Irle[1], Jamie H. Warner[2], Hiromichi Kataura[3,4] and Hisanori Shinohara[1]

1 Department of Chemistry & Institute for Advanced Research, Nagoya University, Nagoya 464-8602, Japan. (e-mail: noris@nagoya-u.jp)
2 Department of Materials, University of Oxford, Parks Road, Oxford, OX1 3PH, UK.
3 Nanosystem Research Institute, National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki 305-8562, Japan.
4 Japan Science and Technology Agency, CREST, Kawaguchi, Saitama 330-0012, Japan.

CNTs are commonly known as a roll-up graphene sheet which can be cleaved [1] to give strips of different widths, called graphene nanoribbons (GNRs). To date, we have learnt about the different ways by which a CNT can be unwrapped, however, how can these flimsy, strips of carbon be rolled to attain a tubular geometry remains elusive. Not until recently, Kit et al. proposed that the CNT can be formed through the twisting of GNR in their theoretical studies [2]. This inspires the study to construct the CNTs via this peculiar means of fabrication.

Herein, we report the first experimental realization of a thermally-induced, self-intertwining of GNRs for the preferential synthesis of CNTs with chiral indices of (7, 2) and (8, 1). The GNRs generated from the PTCDA, a perylene derivative, were transformed into CNTs in the inner space of a host template. Optical measurements performed on the newly grown CNTs revealed a significant enhancement in these two chiralities, matching the predicted chiralites for CNTs formed via the twisting of GNRs with a width of N=5. Our finding adds a radically new aspect to the present understanding of CNT synthesis, shedding much light on the future tuning of not only specific chiral tubes, but also contemporary nanomaterials engineering.

[1] M. Terrones, ACS Nano 4 (2010) 1775-1781
[2] O. O. Kit, T. Tallinen, L. Mahadevan, J. Timonen, P. Koskinen, Phys. Rev. B 85 (2012) 085428