Pseudo-topotactic conversion of carbon nanotubes to T-carbon nanowires in methanol under irradiation of picosecond laser

With the support by the National Natural Science Founddation of China and the Fundamental Research Funds for the Central Universities, a collaborative study led by Zhang JinYing (张锦英) from Xi'an Jiaotong University and Su HaiBin (苏海滨) from Nanyang Technological University produced a new carbon allotrope, T-carbon, from pseudo-topotactic conversion of multi-walled carbon nanotube suspension in methanol by picosecond pulsed-laser irradiation. The results were published in *Nat Commun* (2017, 8: 683).

From naturally existing soft graphite and super hard diamond to synthetic ballistic conducting nanotubes and semiconducting graphene, carbon chemistry never ceases its excitement, and remains to be the best example epitomizing one of the most important principles of the chemistry. That is, structure (bonding) determines properties. The investigation of metastable carbon allotropes in the T-P phase diagram between graphite and cubic diamond phases has been rewarding both experimentally and theoretically and remains a great challenge. Extremely high temperature and pressure can be reached and subsequently quenched to synthesize and trap metastable carbon allotropes by the interactions between pulsed laser and carbon materials.

MWCNTs were prepared by a CVD method to have diameters around 10—20 nm and lengths of dozens of micrometers and subsequently shortened by a sonication method to improve their dispersion. The shortened MWCNTs were well dispersed in absolute methanol. The suspension was then transferred into a self-designed quartz container with an optical path length of 40 mm and preserved under a nitrogen atmosphere. A Q-switched laser with a wavelength of 532 nm, pulse duration of 10 ps, repeating frequency of 1000 Hz, and pulse power of 75 mW was applied. The suspension was irradiated by the laser beam for one hour while it was kept under a nitrogen atmosphere and stirred with a magnetic stir bar. The NWs produced from laser irradiation of MWCNTs in methanol under nitrogen atmosphere have been so far confirmed to be sp^3 hybridized carbon NWs with a cubic crystal lattice. The FFT patterns of one single carbon NW at different tilting angles (Figure) were used to further confirm the crystal lattice of the carbon NWs to be T-carbon ($Fd\bar{3}m$ (227)) with a lattice constant of 7.80 Å.

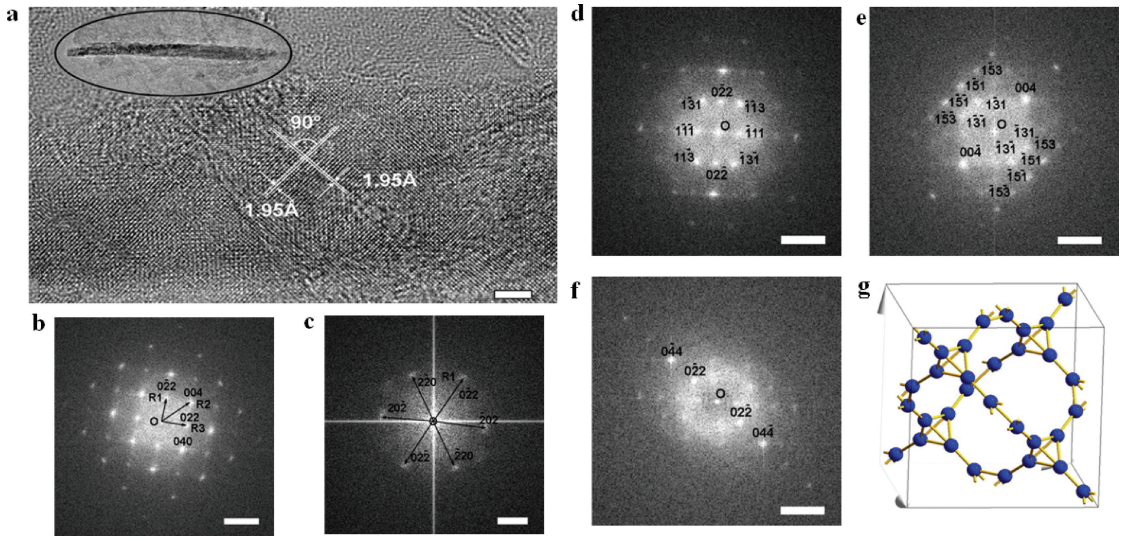

Figure Structure characterization and structural model of T-carbon NWs.