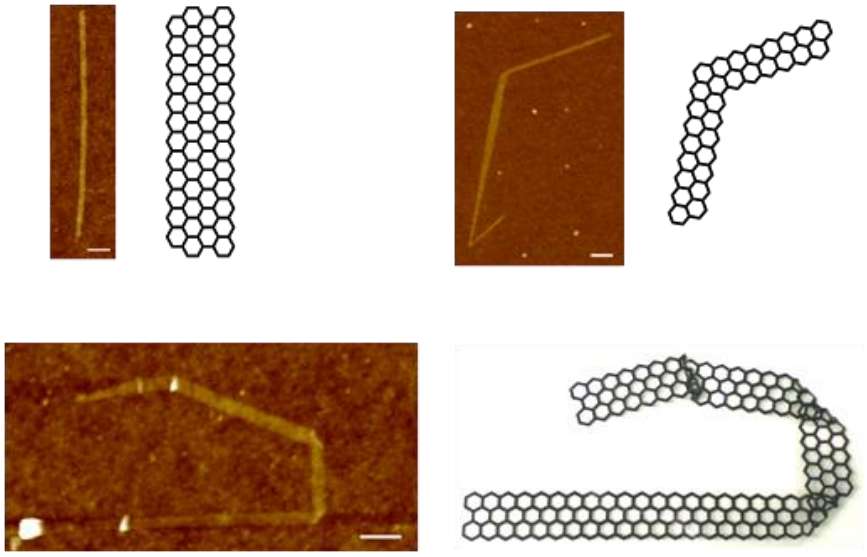
Graphene Nanoribbons



Xiaolin Li, et al., ***Science***, 2008.

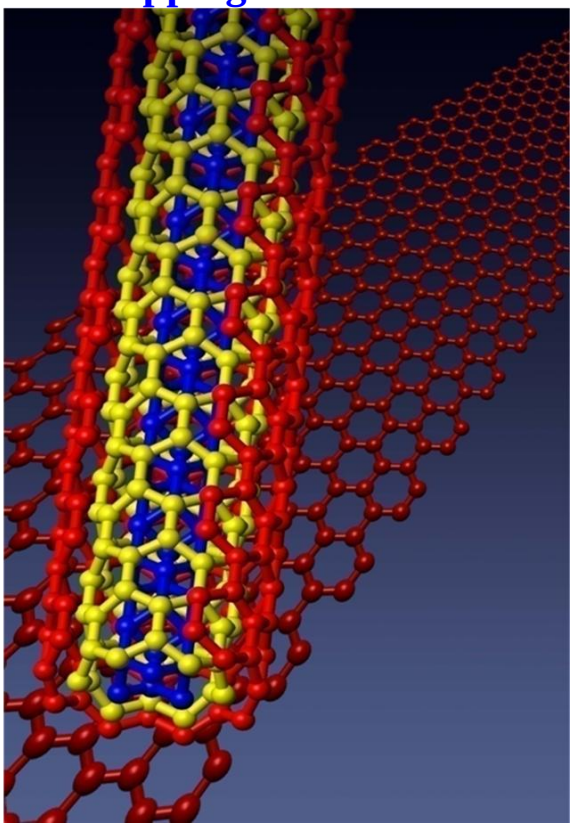
Unzipping of Nanotubes

Unzipping Nanotubes

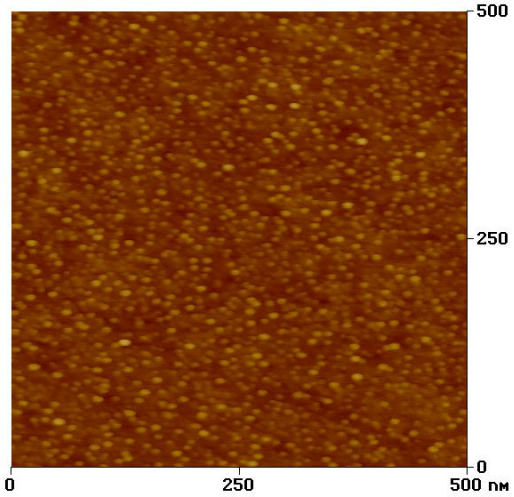
Graphene Nanoribbons

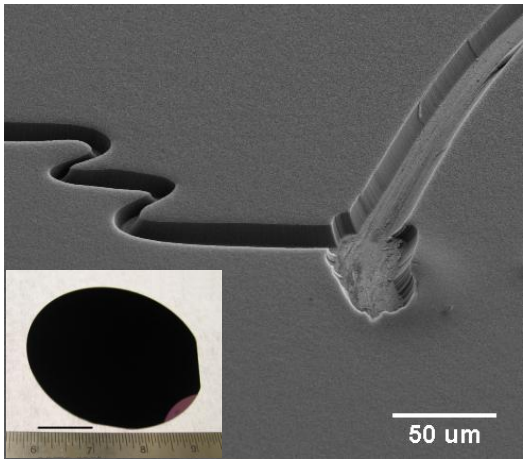
(L. Jiao, et. al., **Nature**, 2009;

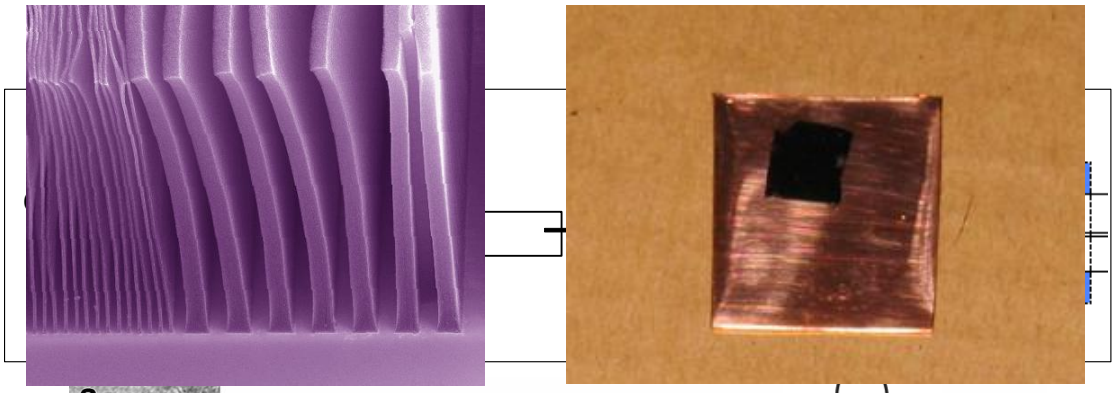
J. Tour group, **Nature**, 2009)

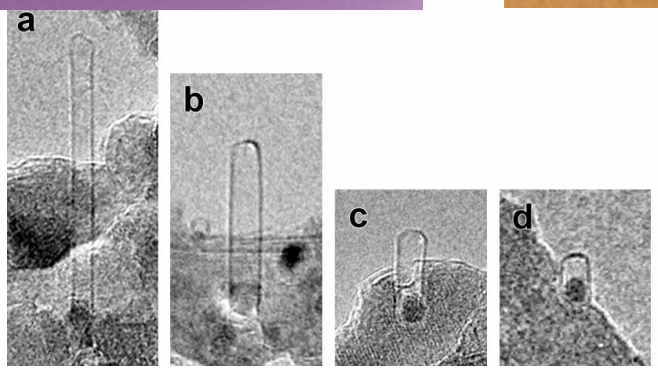


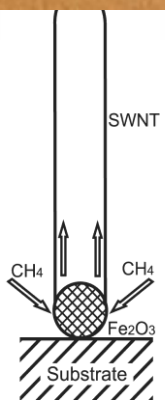
Self-Oriented Vertical Single-Walled NTs







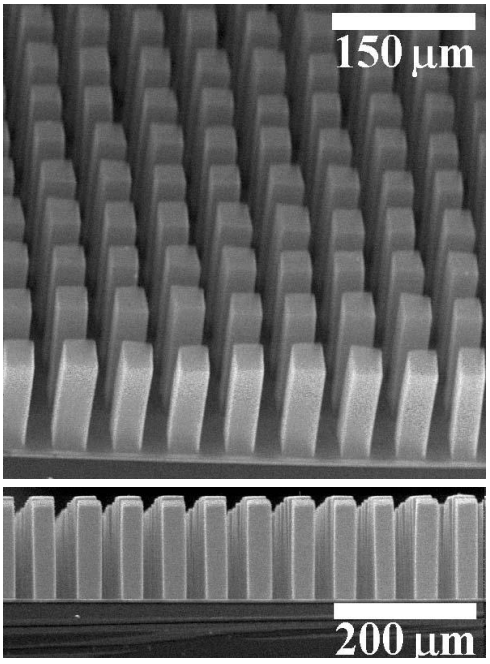


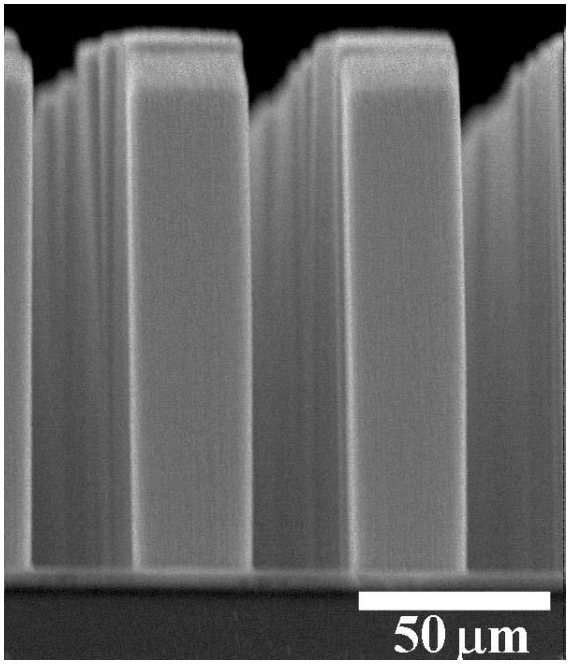


Base growth

Yuegang Zhang, Yiming Li, J. Phys. Chem, 1999;

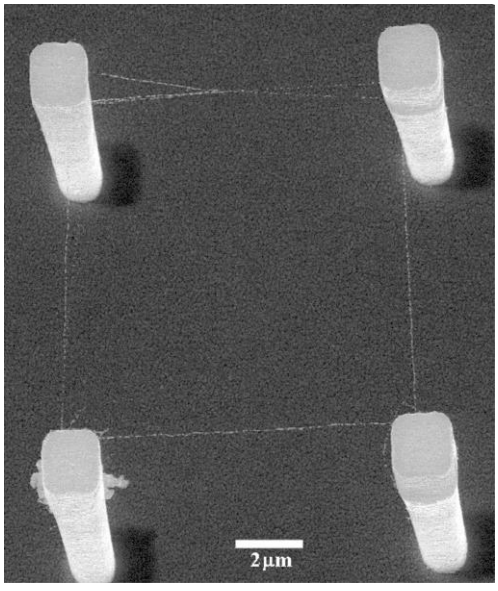
Self-Oriented Vertical Multi-Walled NTs



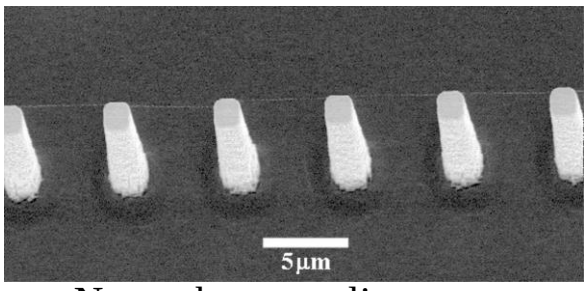


Shoushan Fan, Nathan Franklin, et. al., *Science*, 1999.

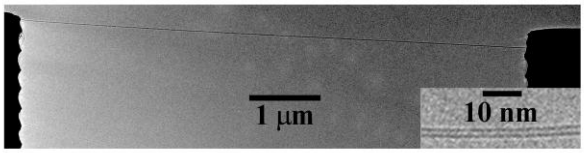
Suspended Nanotubes



Nanotube square



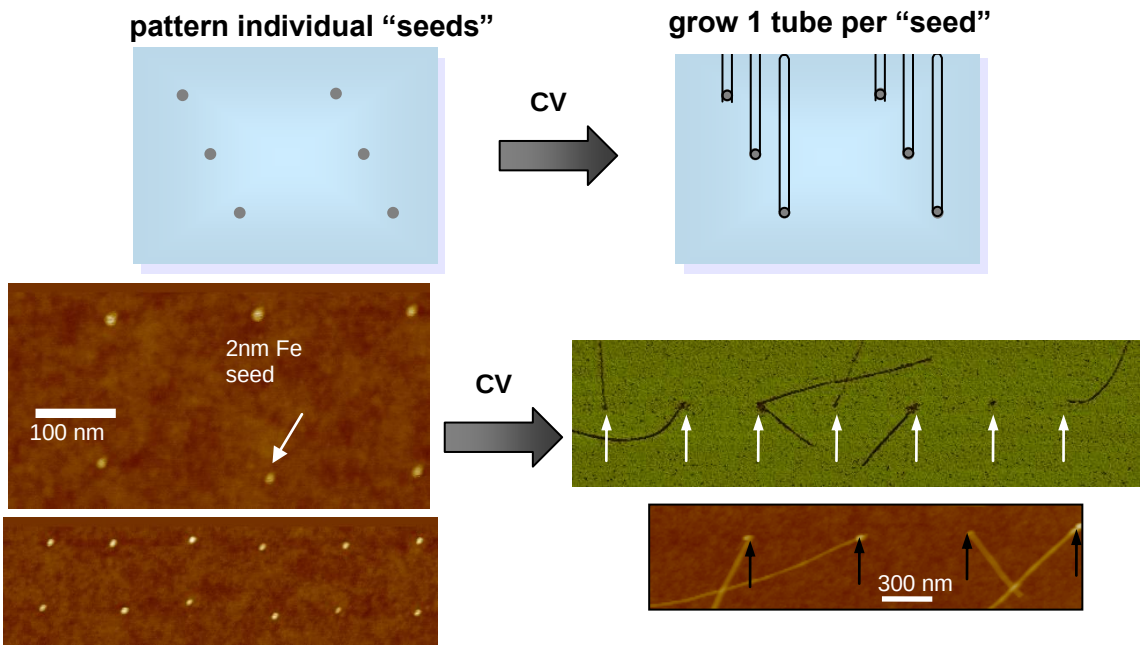
Nanotube powerline



TEM: Single-Walled

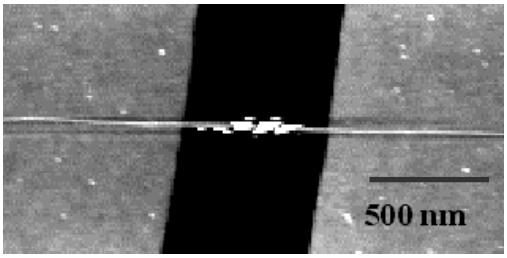
Alan Cassell, Nathan Franklin, *JACS*, *Adv. Mat.*, 1999-2000

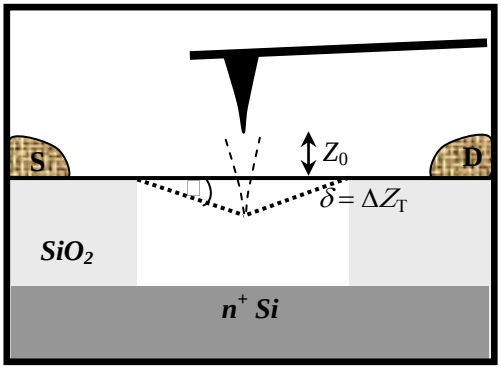
SWNTs Synthesis From Individual Nanoparticles



Ali Javey, *JACS*, 2005

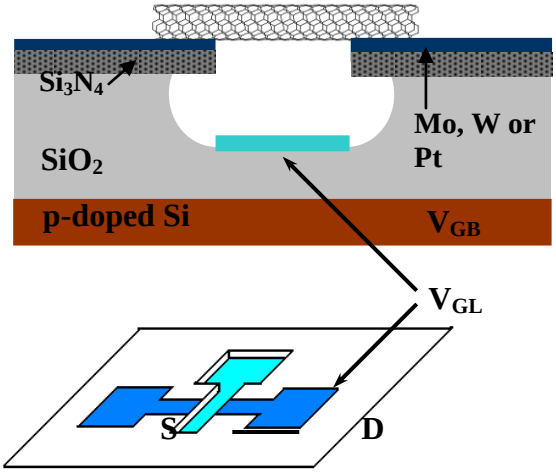
Electromechanical Properties of Suspended Nanotubes

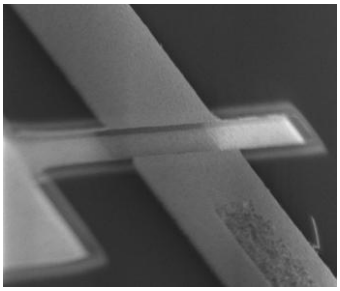


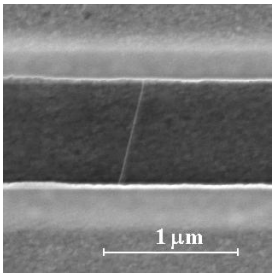


Thomas Tombler, Chongwu Zhou, et al., *Nature*, 2000;
Jien Cao, et al., *PRL*, 2004.

Suspended Nanotubes:
Very High Quality & Unperturbed

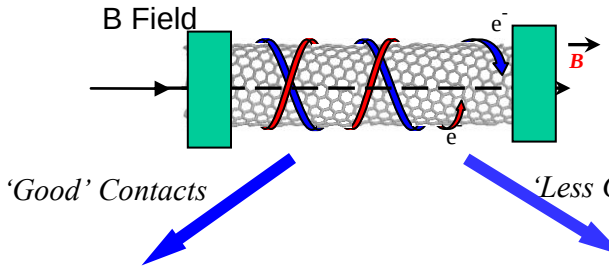






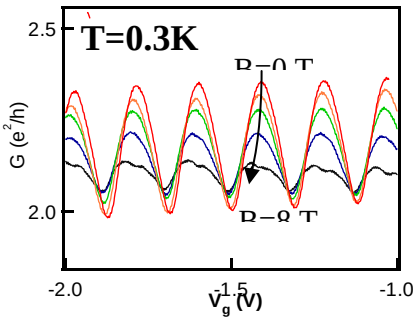
As-*grown* between Pt across trenches
Exhibit 'clean' quantum transport signatures.

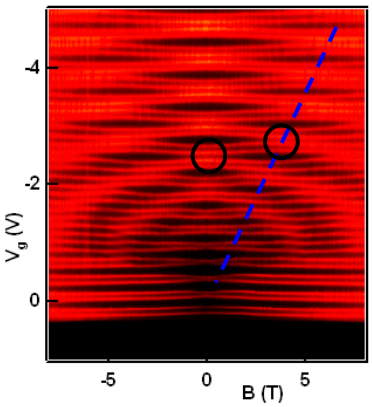
Quantum Transport (Aharonov Bohm Effect)



'Good' Contacts *'Less Good'*

Multi-Turn FP Interference

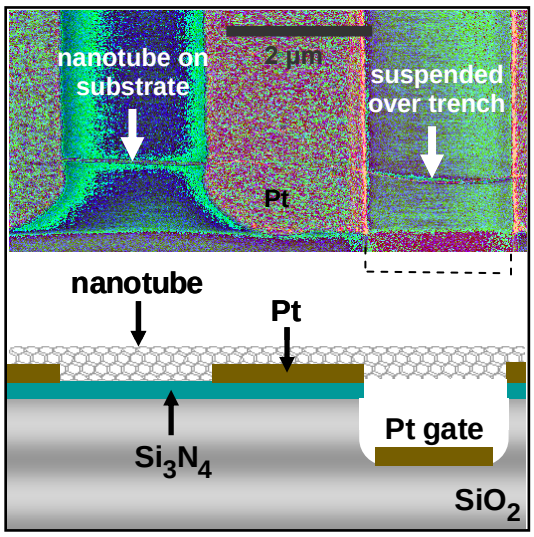


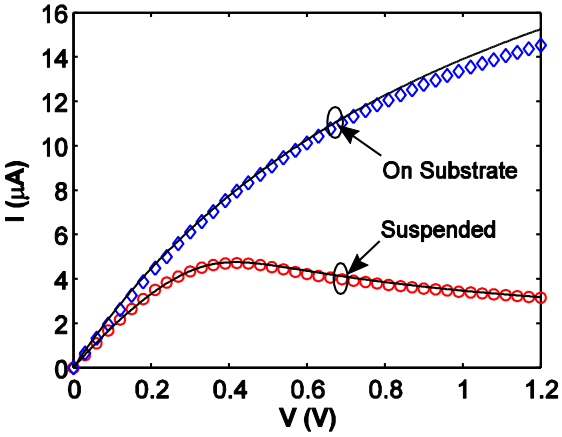


Shells of single-e's split & cross in B Field

Jien Cao et al, *PRL*, 2004; *Nature Materials*, 2005

Non-Equilibrium Hot Phonons in Suspended Tubes

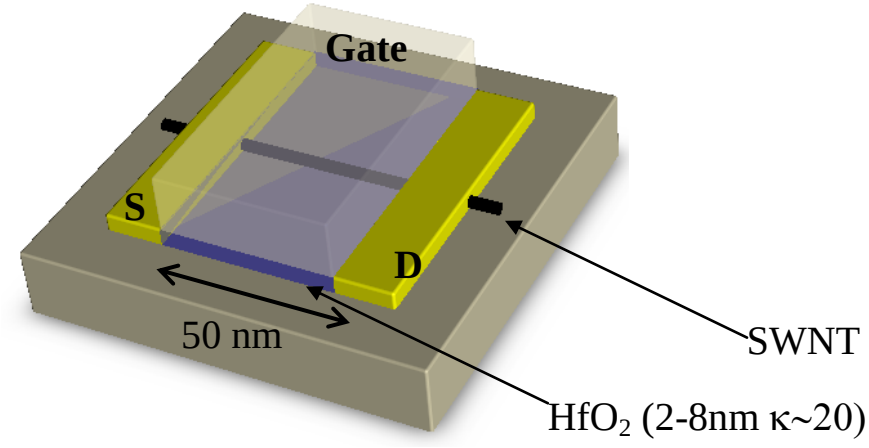




Negative differential conductance (NDC) & hot phonons

Eric Pop, David Mann et al., PRL, 2005

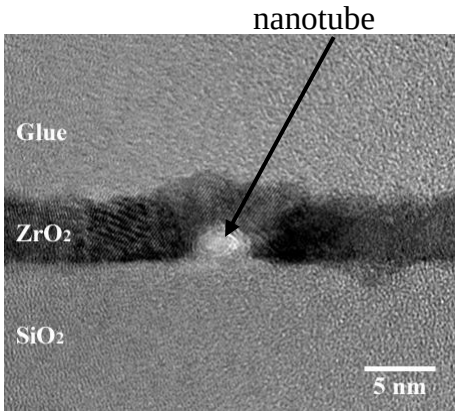
Pushing the Limit of Nanotubes Field Effect Transistors (FETs)

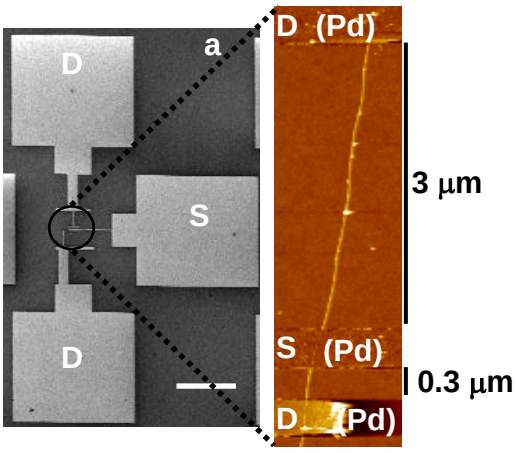


CNTs are advanced electronic materials owing to:

- Strong bonding (*high current carrying; High phonon energy*)
- Stable and inert surfaces

High-κ Dielectrics, Ohmic Contacts and Channel Scaling





Ali Javey
Jing Guo, Mark Lundstrom,
Paul McIntyre,
Damon Farmer, Roy Gordon
Nature Materials, 2002; *Nature* 2003; *Nano Lett.*, 2004;