Graphene Nanoribbons


Unzipping of Nanotubes

Unzipping Nanotubes

Graphene Nanoribbons

(L. Jiao, et. al., *Nature*, 2009;
Self-Oriented Vertical Single-Walled NTs

Yuegang Zhang, Yiming Li, J. Phys. Chem, 1999;
Self-Oriented Vertical Multi-Walled NTs


**Suspended Nanotubes**

SWNTs Synthesis From Individual Nanoparticles

pattern individual “seeds”

grow 1 tube per “seed”

Ali Javey, *JACS*, 2005

Electromechanical Properties of Suspended Nanotubes

Suspended Nanotubes:
Very High Quality & Unperturbed

As-grown between Pt across trenches
Exhibit ‘clean’ quantum transport signatures.
**Quantum Transport (Aharonov Bohm Effect)**

![Diagram of quantum transport with Aharonov Bohm Effect](image)

'Good' Contacts

'Less Good'


*Nature Materials*, 2005

---

**Non-Equilibrium Hot Phonons in Suspended Tubes**

![Diagram of nanotube structure](image)

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