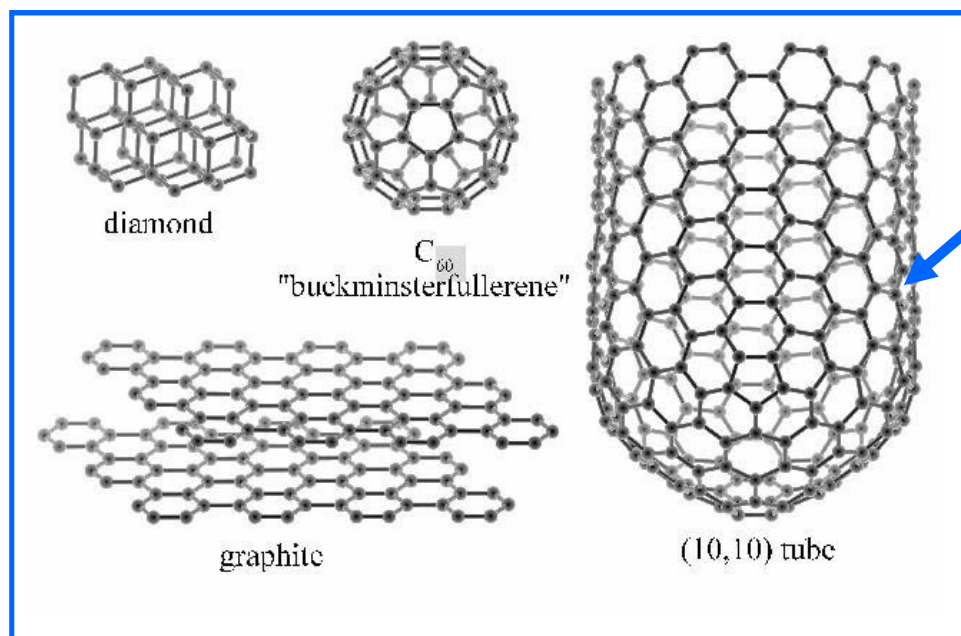
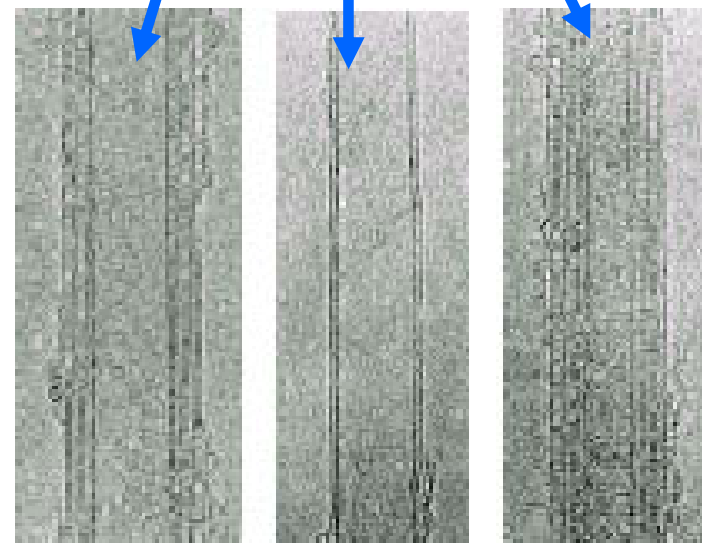


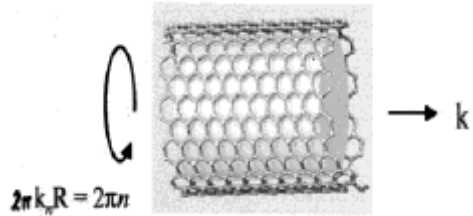
What are Carbon Nanotubes?



Two Forms:
Single Wall (**SWNT**) and
Multi Wall(**MWNT**)



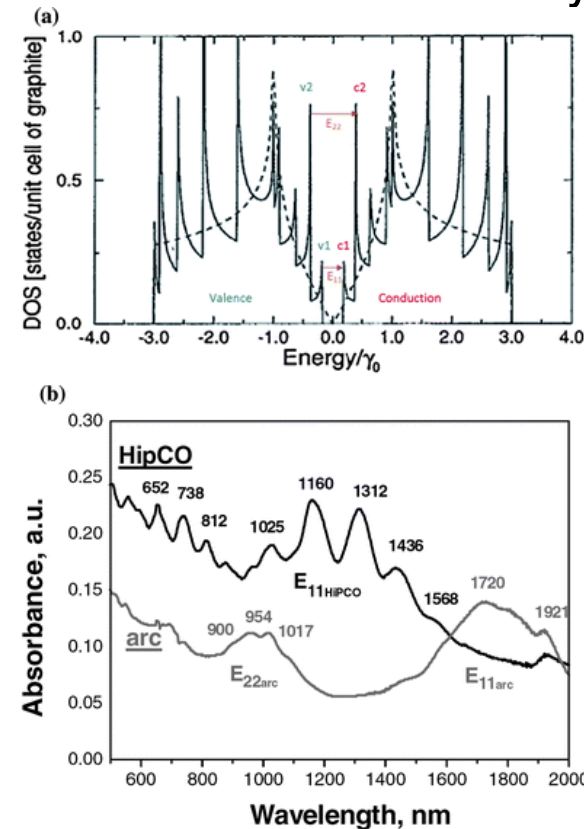
Optical Absorption



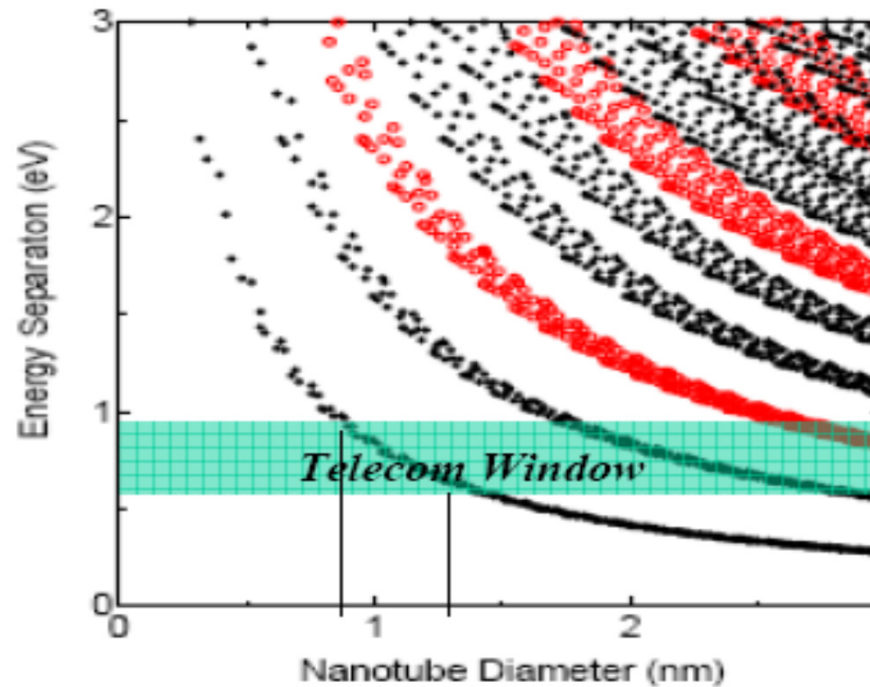
Optical Transitions allowed between valence and conduction bands of the same symmetry.

Energy is a function of:
diameter and chirality
 $(n-m)/3 = \text{remainder of}$
1 or 2 a semiconductor
0 a metallic

different tubes have a
different energy spacing



(a) The electronic density of states for a (10,0) zigzag semiconducting single-walled CNT.
(b) Absorption spectra of two types of CNTs in polymer films.



Adopted from Maruyama, S. <http://www.photon.t.u-okyo.ac.jp/~maruyama/kataura/kataura.html>

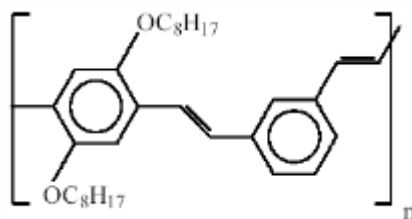
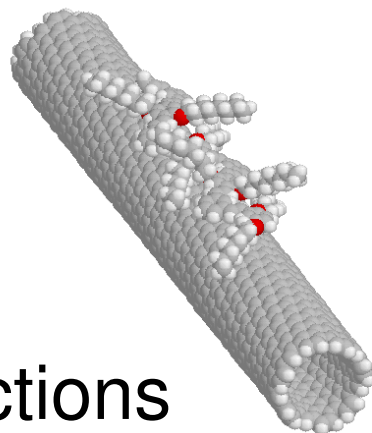
- Residual C-H vibrational absorptions absent
- Resistant to degradation

Blau & Wang, Nature Nanotech (Dec 2008)

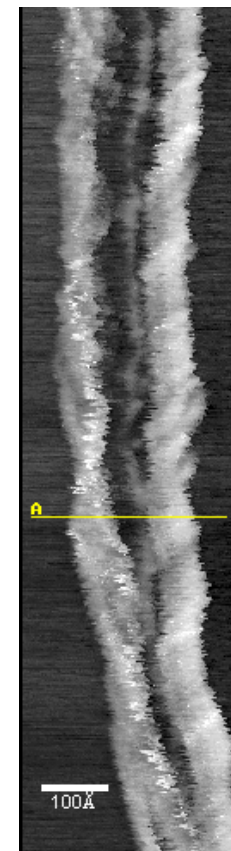
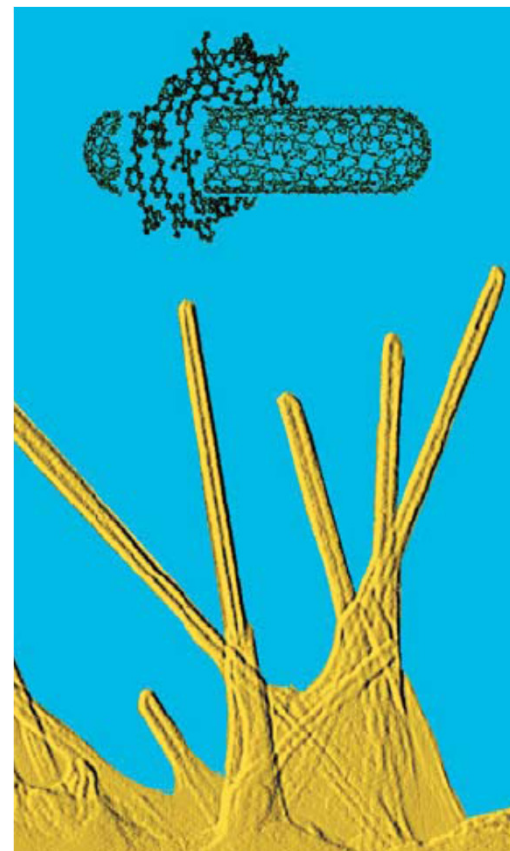
- They are extremely tuneable, covering the near infrared and visible.
- They have intrinsically fast non linear optical response. The one dimensional confinement of the excitations implies a short lifetime and very large oscillator strength, concentrated in a narrow resonance. Lifetime can be accelerated by bundling.
- In polymer composites, they offer a natural way towards miniaturization.
- They have extremely good transport properties, promising development in optoelectronics
- They have large compatibility and integration with both organic and inorganic semiconductors and substrates, especially Si.

Blau & Wang, Nature Nanotech (Dec 2008)

- π - π interactions

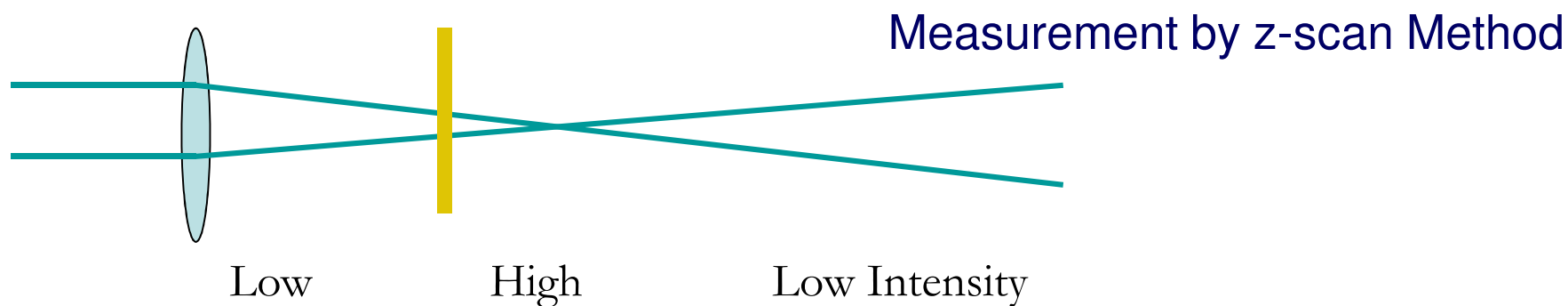


Poly(m-phenylenevinylene-co-2,5-dioctoxy-p-phenylenevinylene)



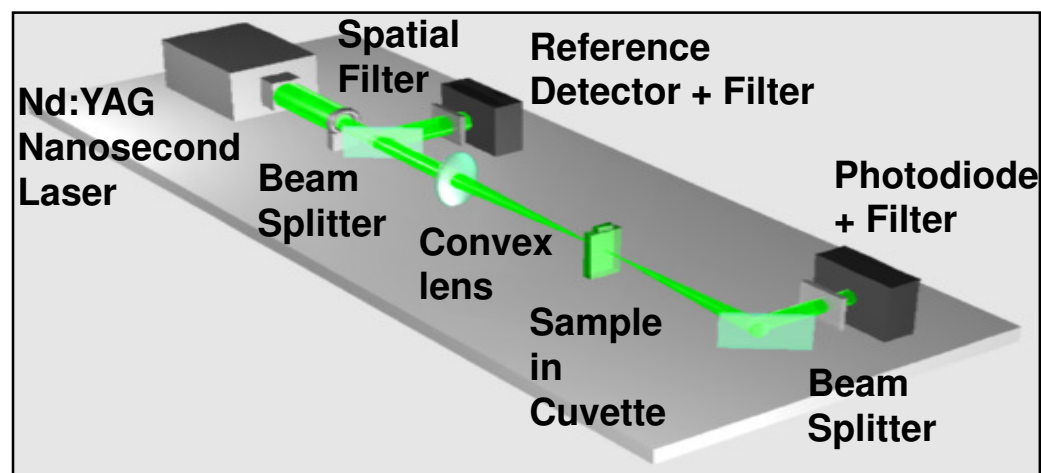
SA Curran et al., Adv. Mater.**10** (1998) 1091

Intensity Dependent Optical Properties

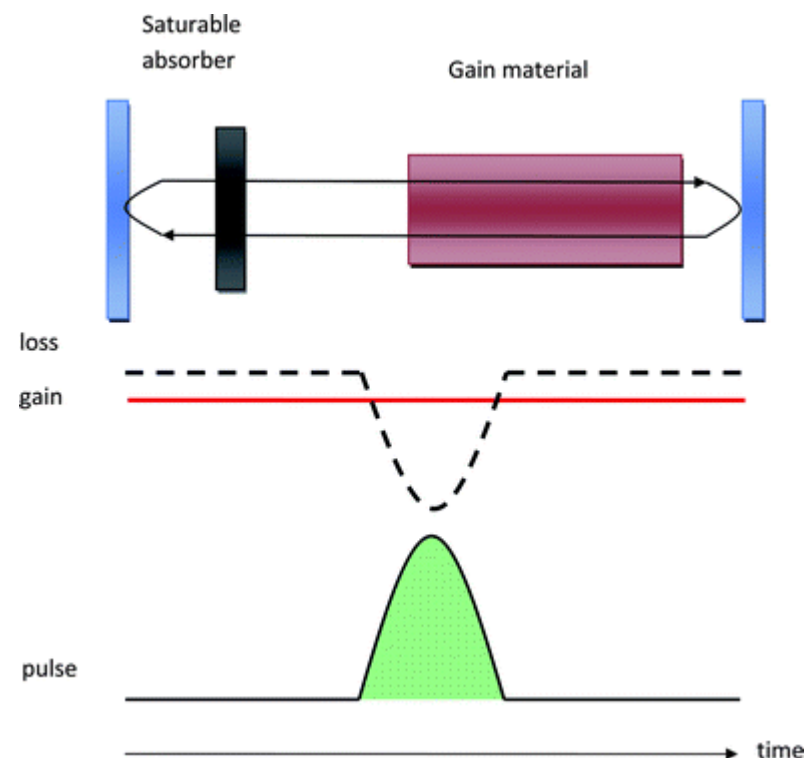
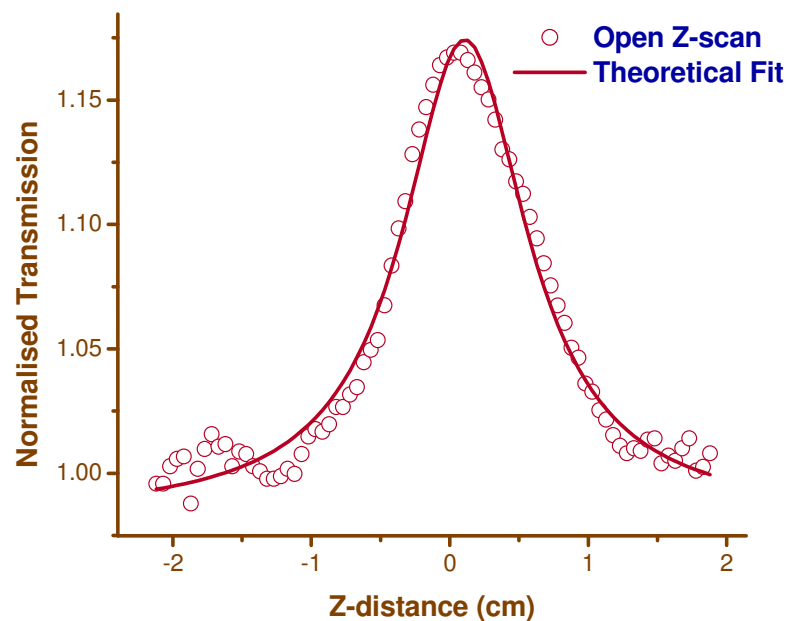


Sample moves in z-direction ->

First observed in CNTs
by Curran et al.
Synth. Met. 1999

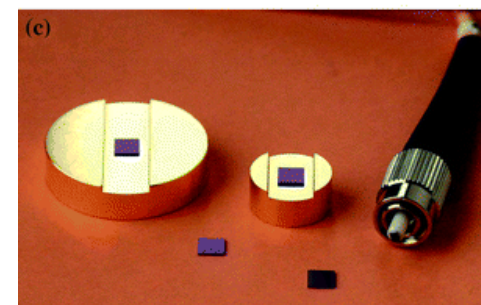
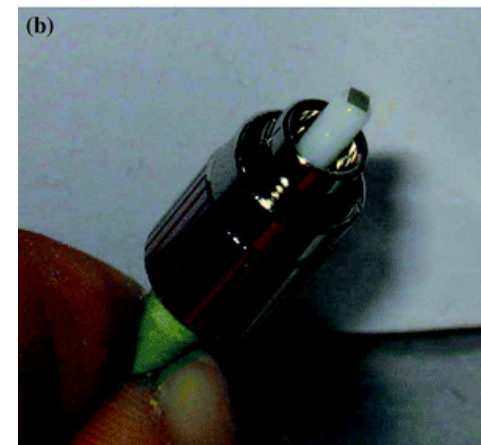
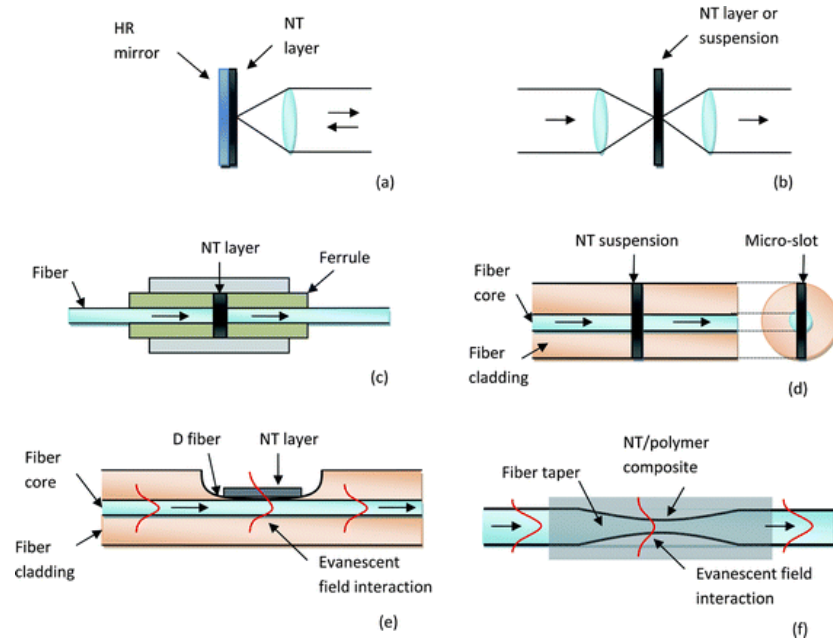


Saturable Absorbers Incorporating NanoTube SAINT

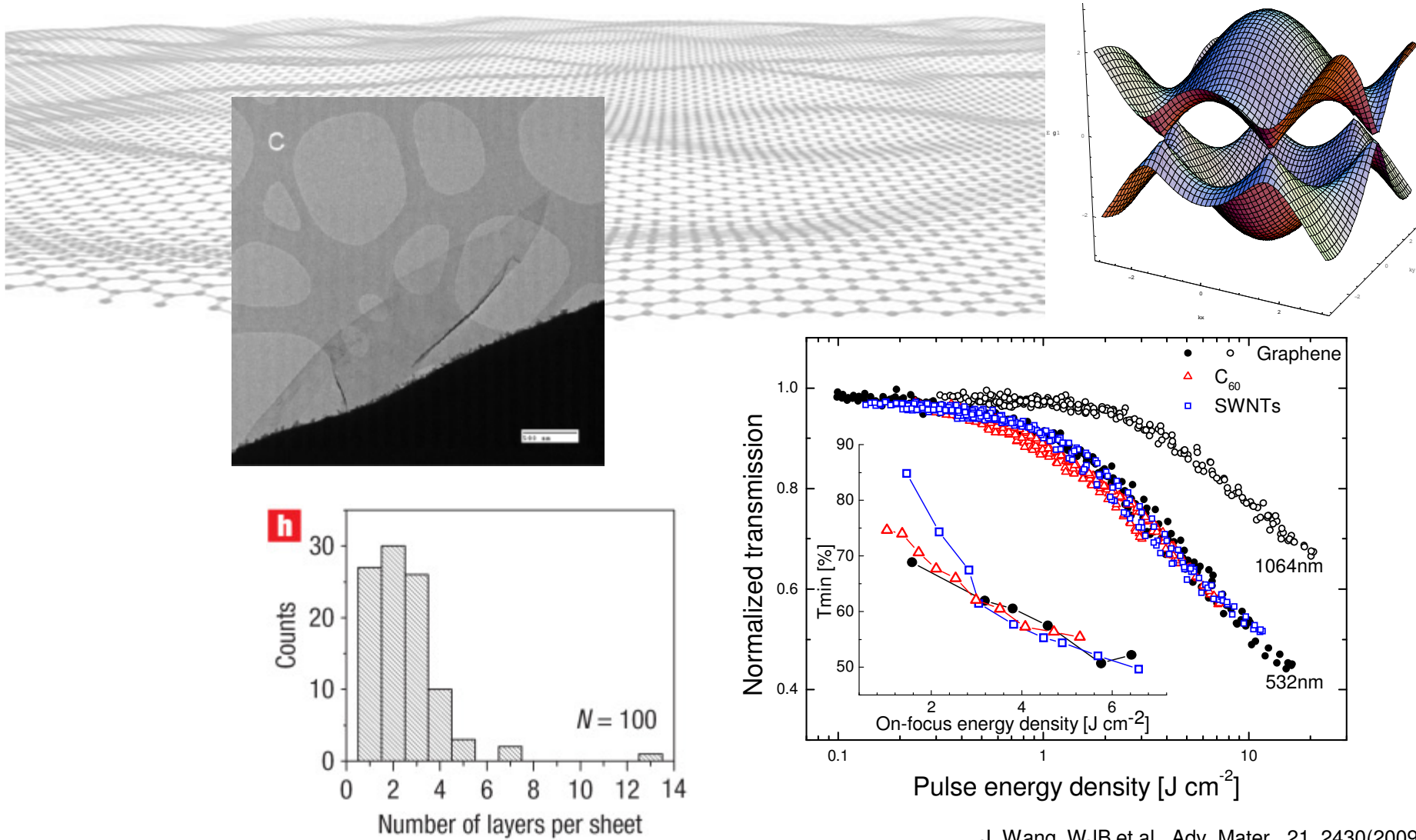


Reviewed by Jun Wang & WJB
J Mater Chem 2009

Saturable Absorbers Incorporating NanoTube SAINT



Graphene



J. Wang, WJB et al., Adv. Mater., 21, 2430(2009)