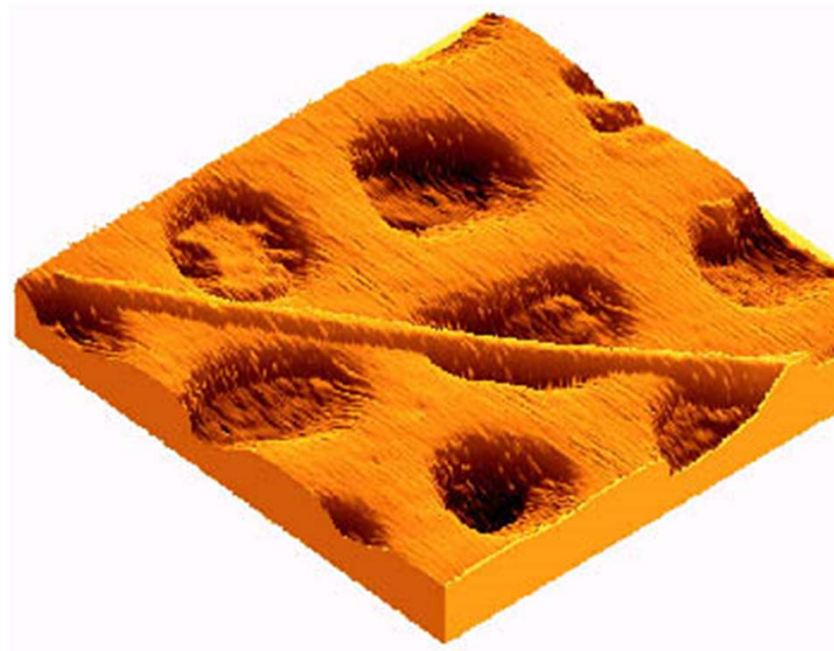


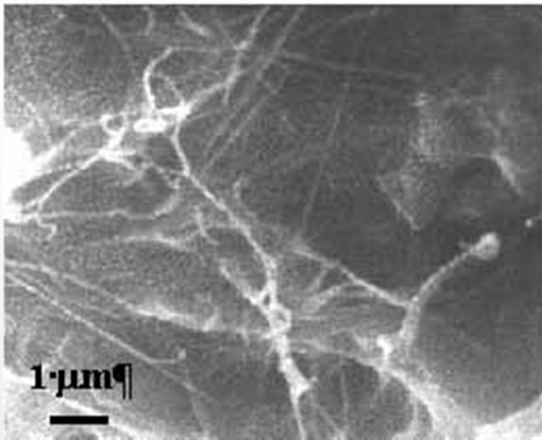
Carbon nanotubes

J. A.



nanotube resting
on porous ceramic
(AFM scan)

Nanotube composites II

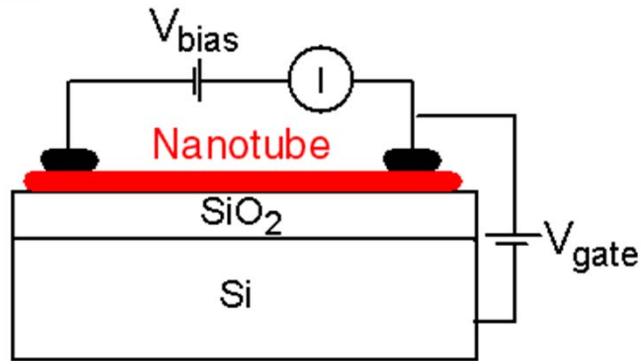


nanotubes in
polyepoxide

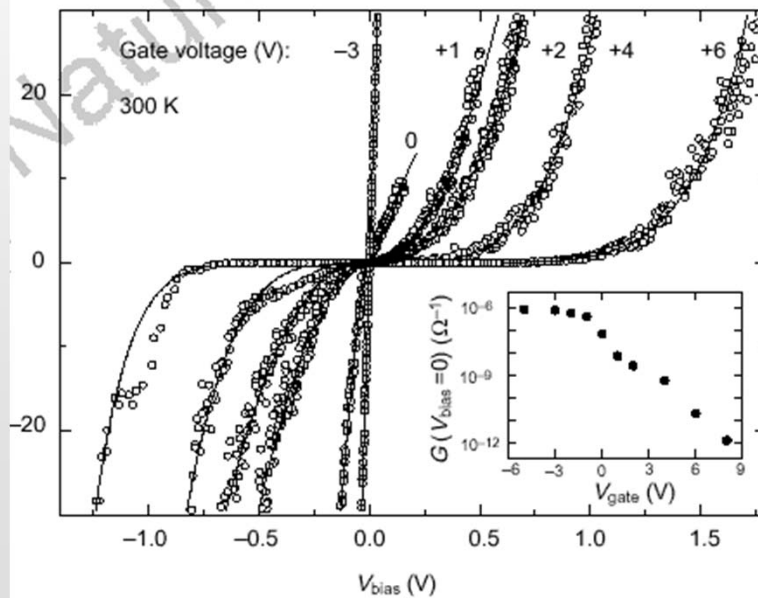
- Attaching chemical groups – benzyne – soldier's armour
- Epoxy glue 3 times harder
- Carbide strength – alternative layers polymer, nanotubes
- Thin layer of composite on other materials, nanocomposite paint, grease

Also composites with ceramics

Transistor components

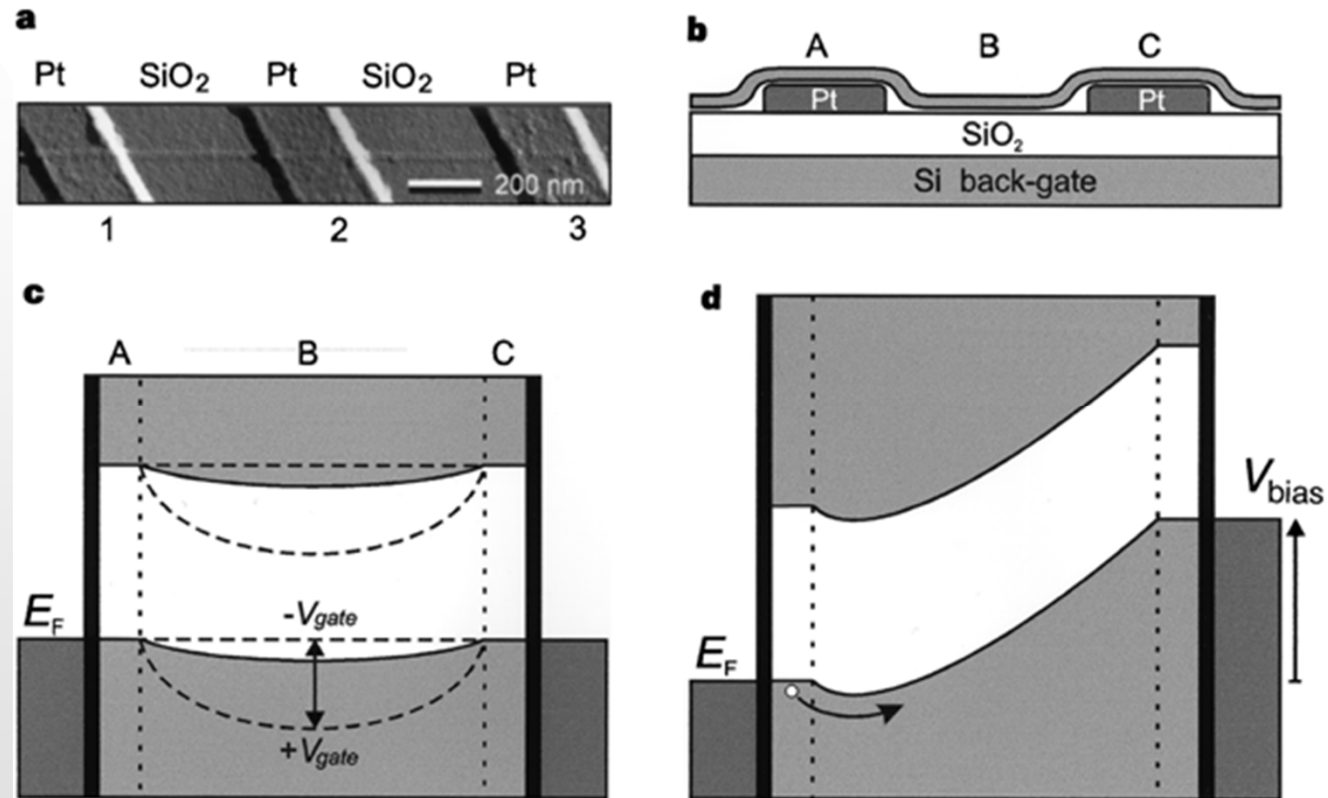


- < 5 nm width compared with existing best width of $xx \mu\text{m}$ for Si circuits



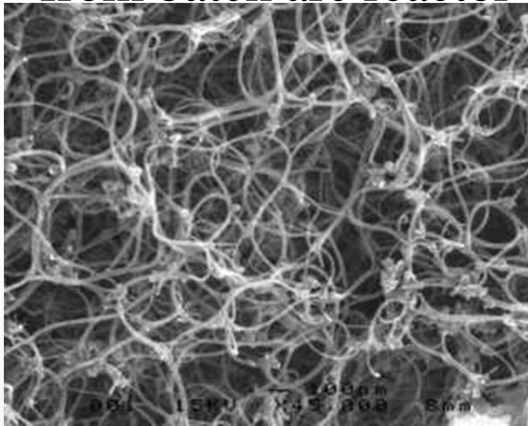
Transistor nanotube

nanotube ->



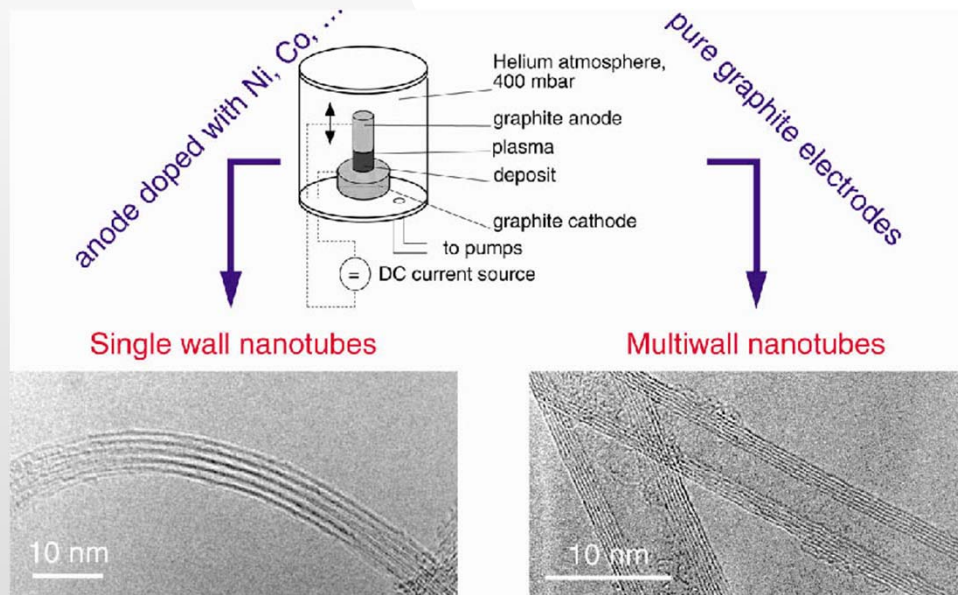
1998 in Nature

multiwall nanotubes
from batch arc reactor

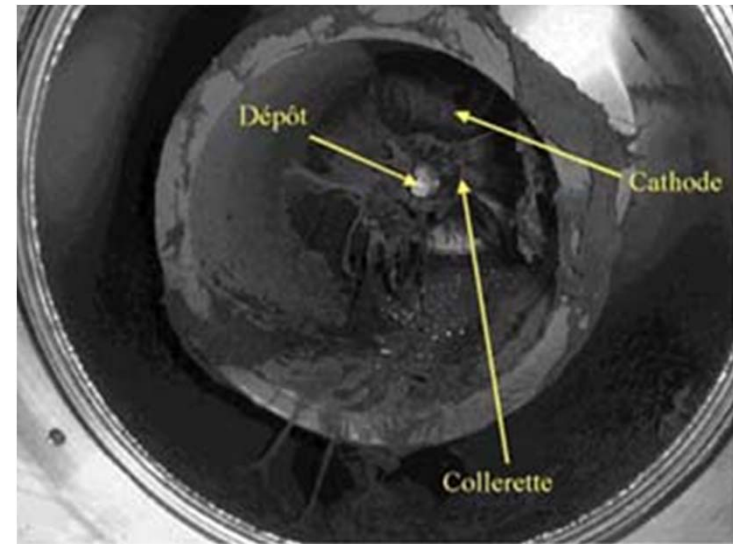


Making nanotubes

- Electric arc - batch reactor
- scaleup - continuous reactor



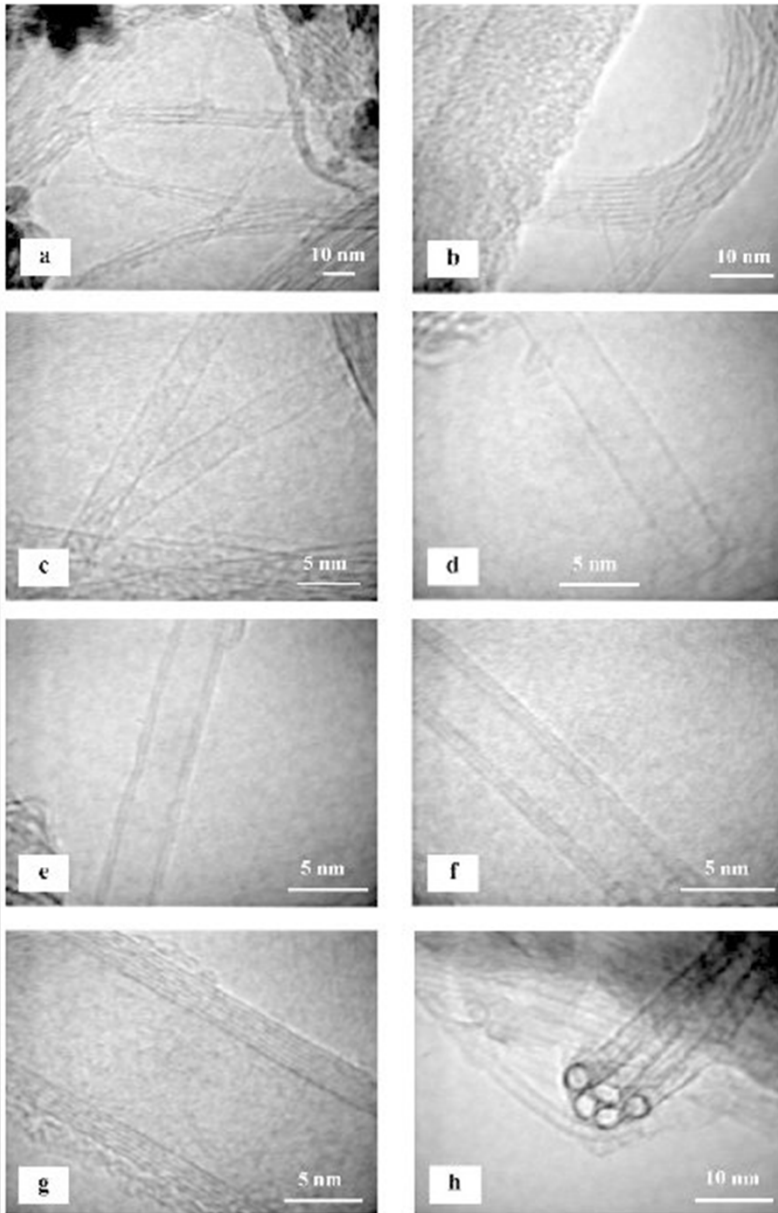
batch reactor operation



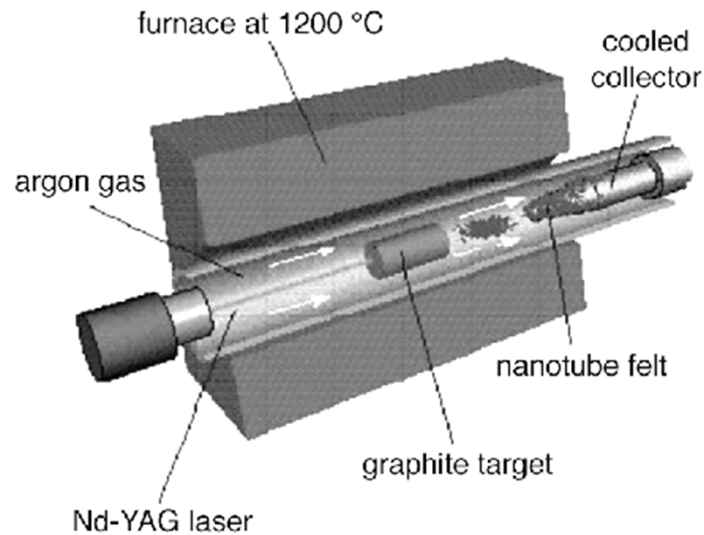
cathode deposit

Nanotube TEM's

- Pick out nanotube ropes

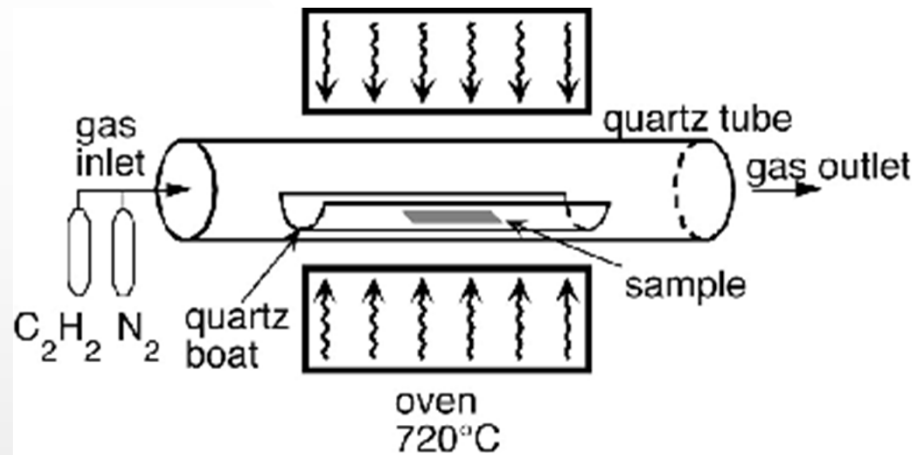


Laser production



- Yields >70% SWNT if double pulsed
- Ropes 10-20 nm dia, 100 μm length
- How to scale up?

Chemical vapour deposition (CVD)



Also can use suspended catalyst nanoparticles to form suspended NT

Acetylene over iron nanoparticles 700°C forms MWNT covered with amorphous C on outer layer

Ethylene, hydrogen + methane over Co, Ni, Fe nanoparticles at 1000°C forms 70-80% SWNT uncapped

- $2\text{CO} \rightarrow \text{C} + \text{CO}_2$ also forms NT

Low stiffness, strength of NT compared with those from high T arc production