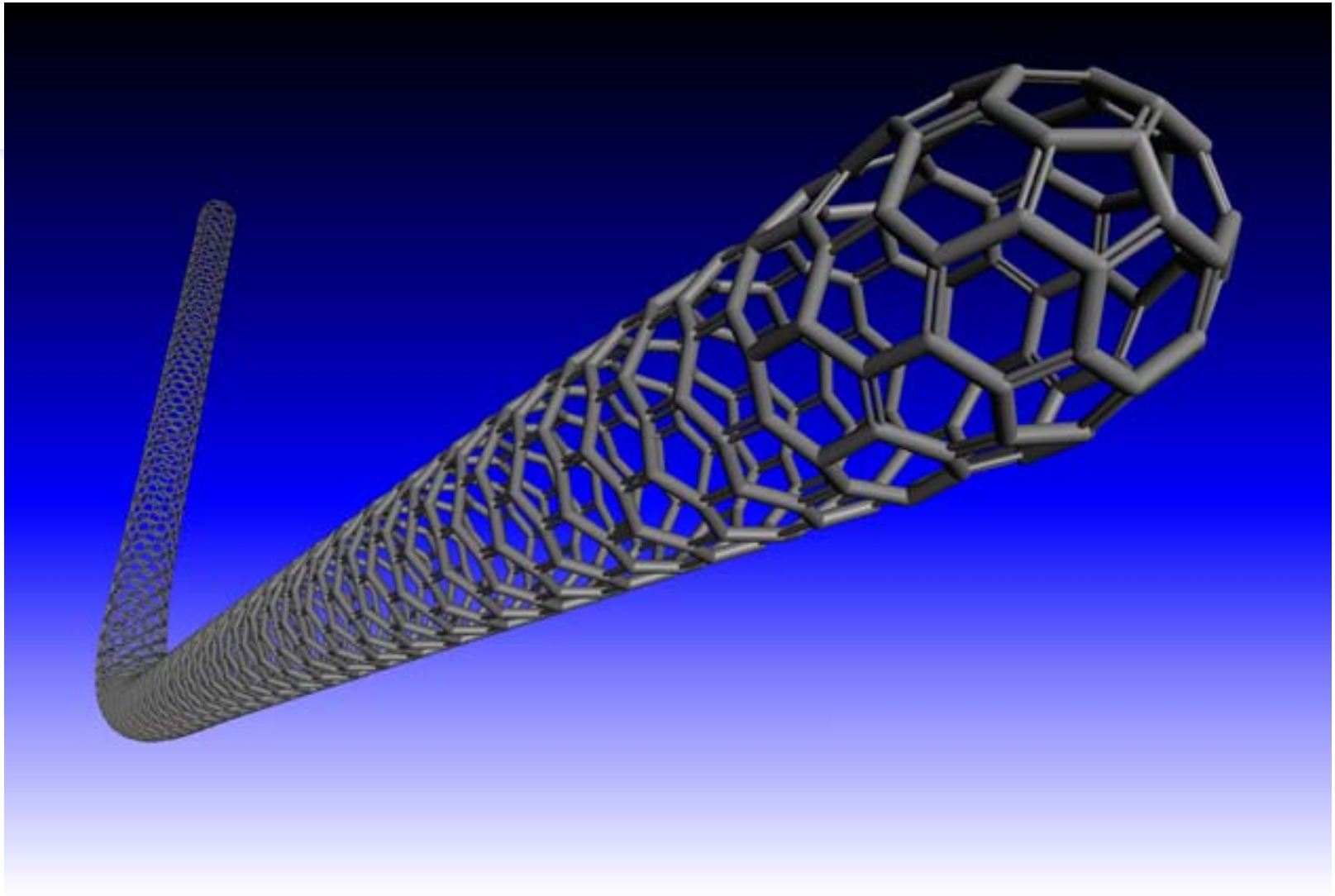
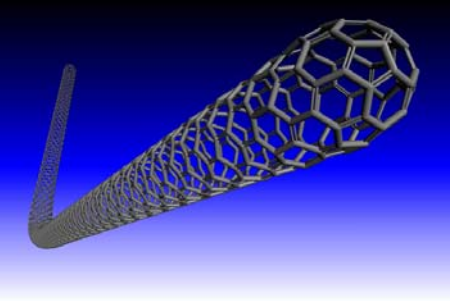


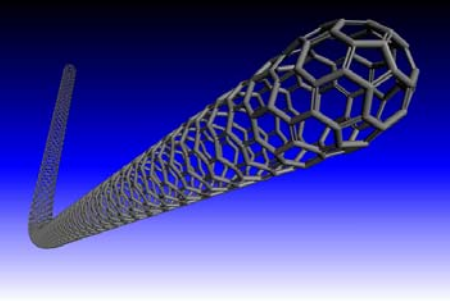
Poster Session A: Synthesis



Poster Session A: Synthesis

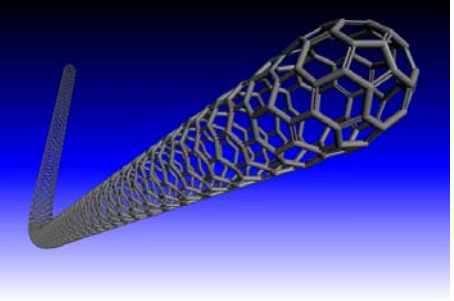
76 papers !

Firstly: an overview……

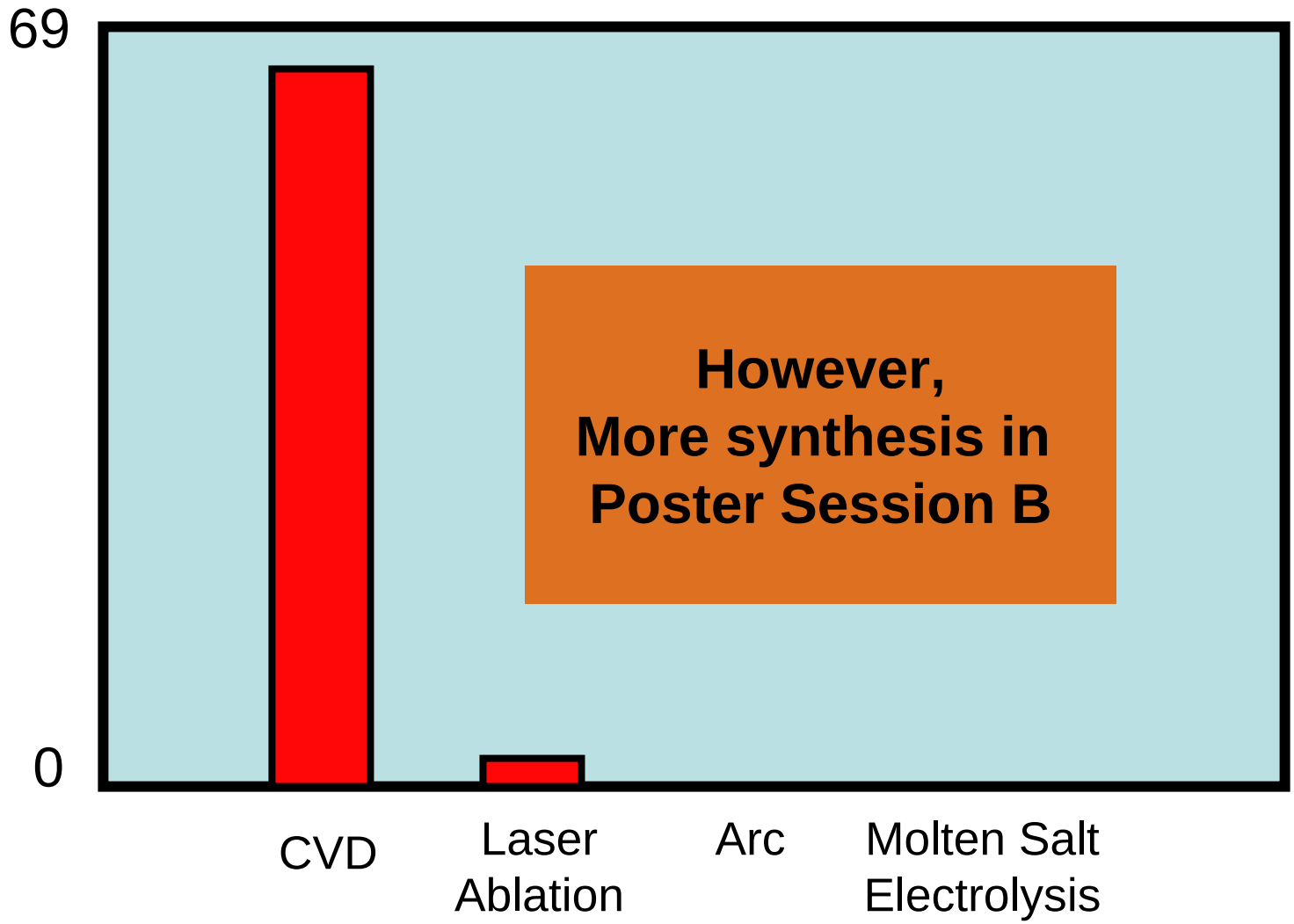


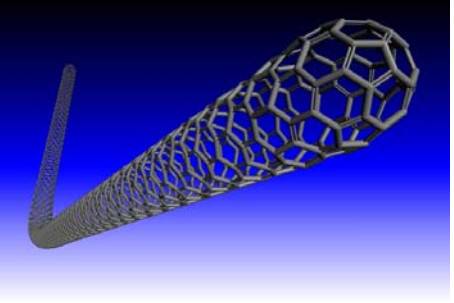
Poster Session A: Synthesis

Theory and Modelling	4
Measurement Development	4
Experimental	68

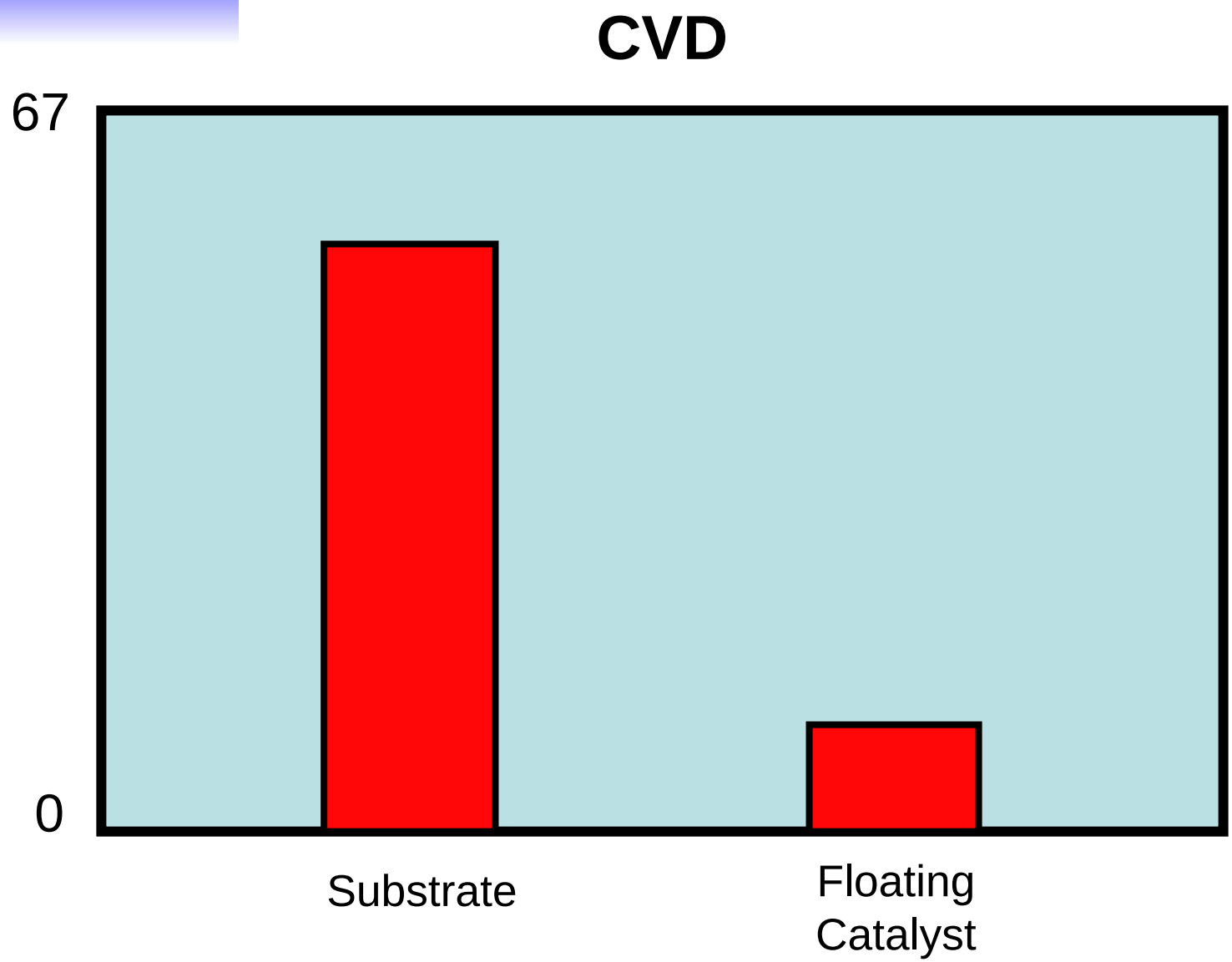


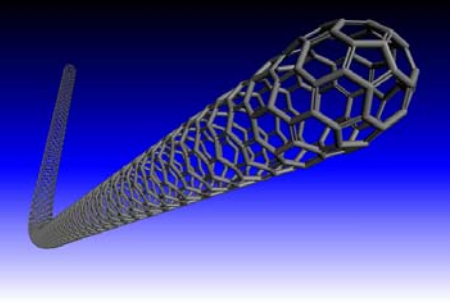
Poster Session A: Synthesis



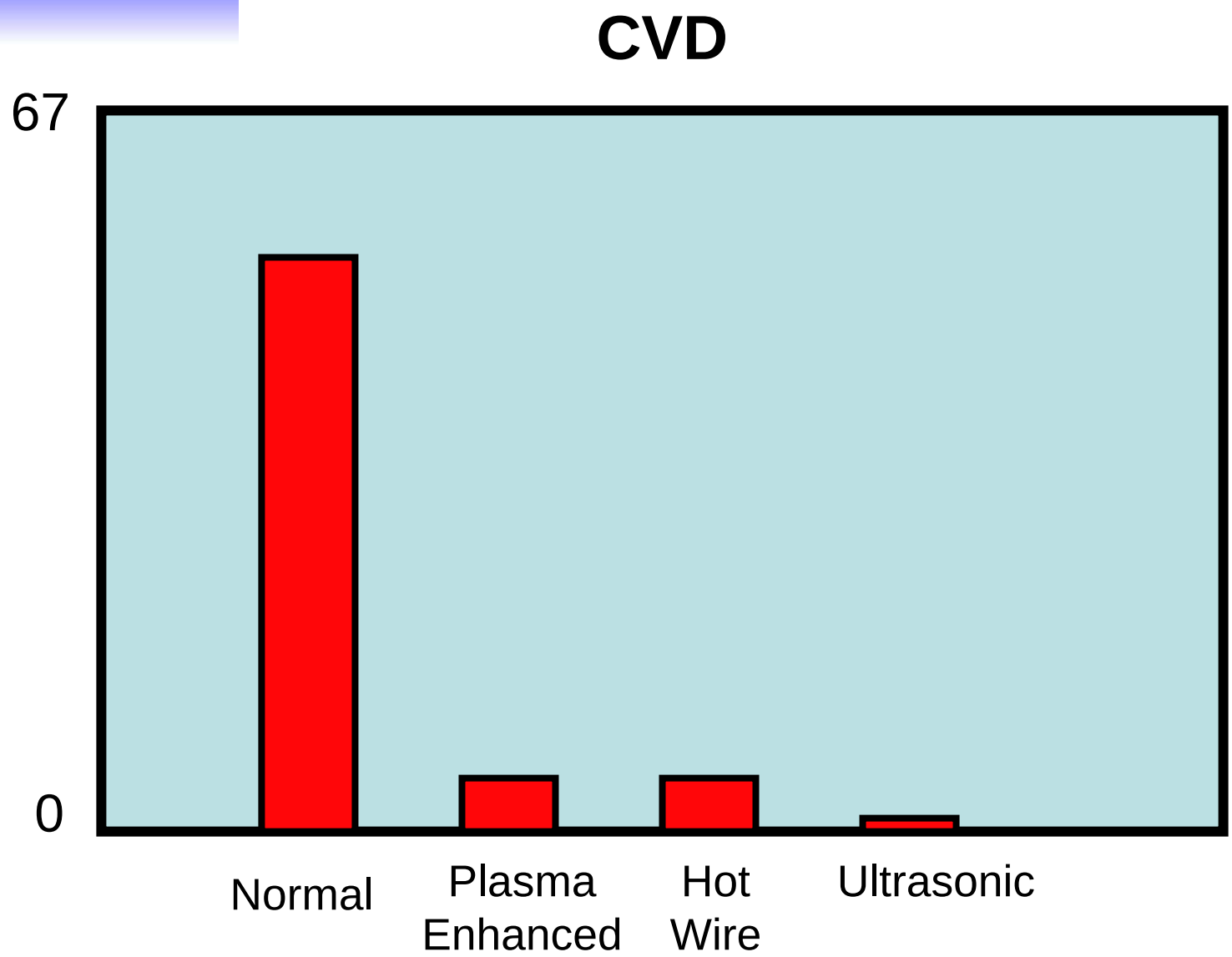


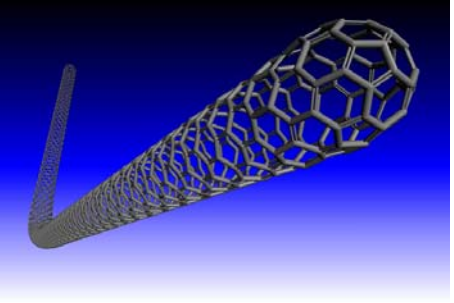
Poster Session A: Synthesis





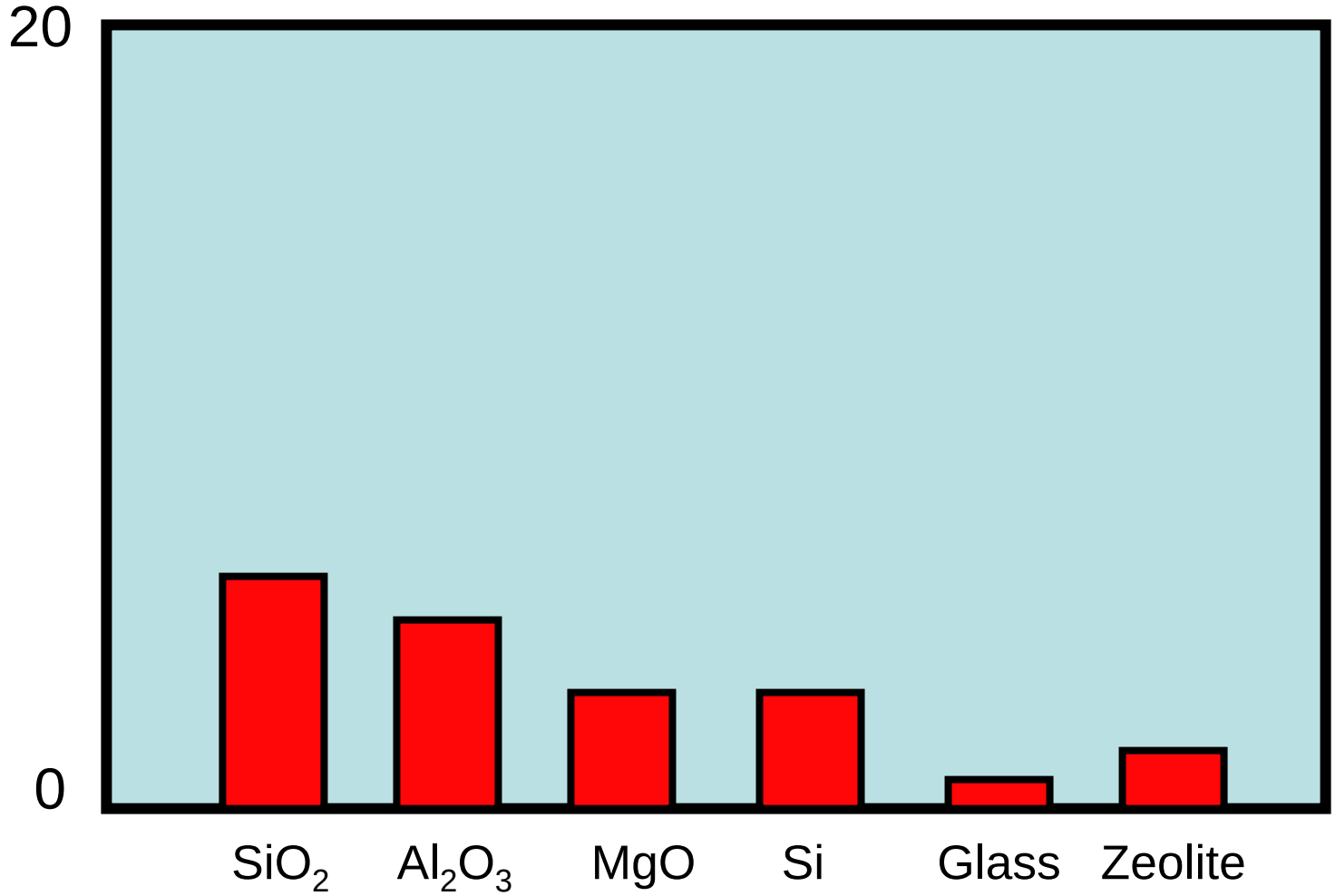
Poster Session A: Synthesis

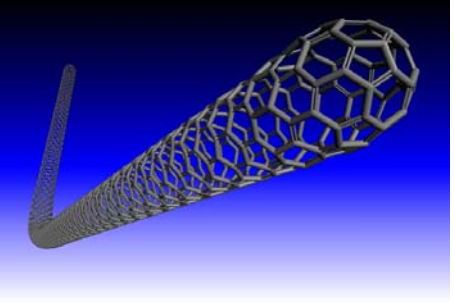




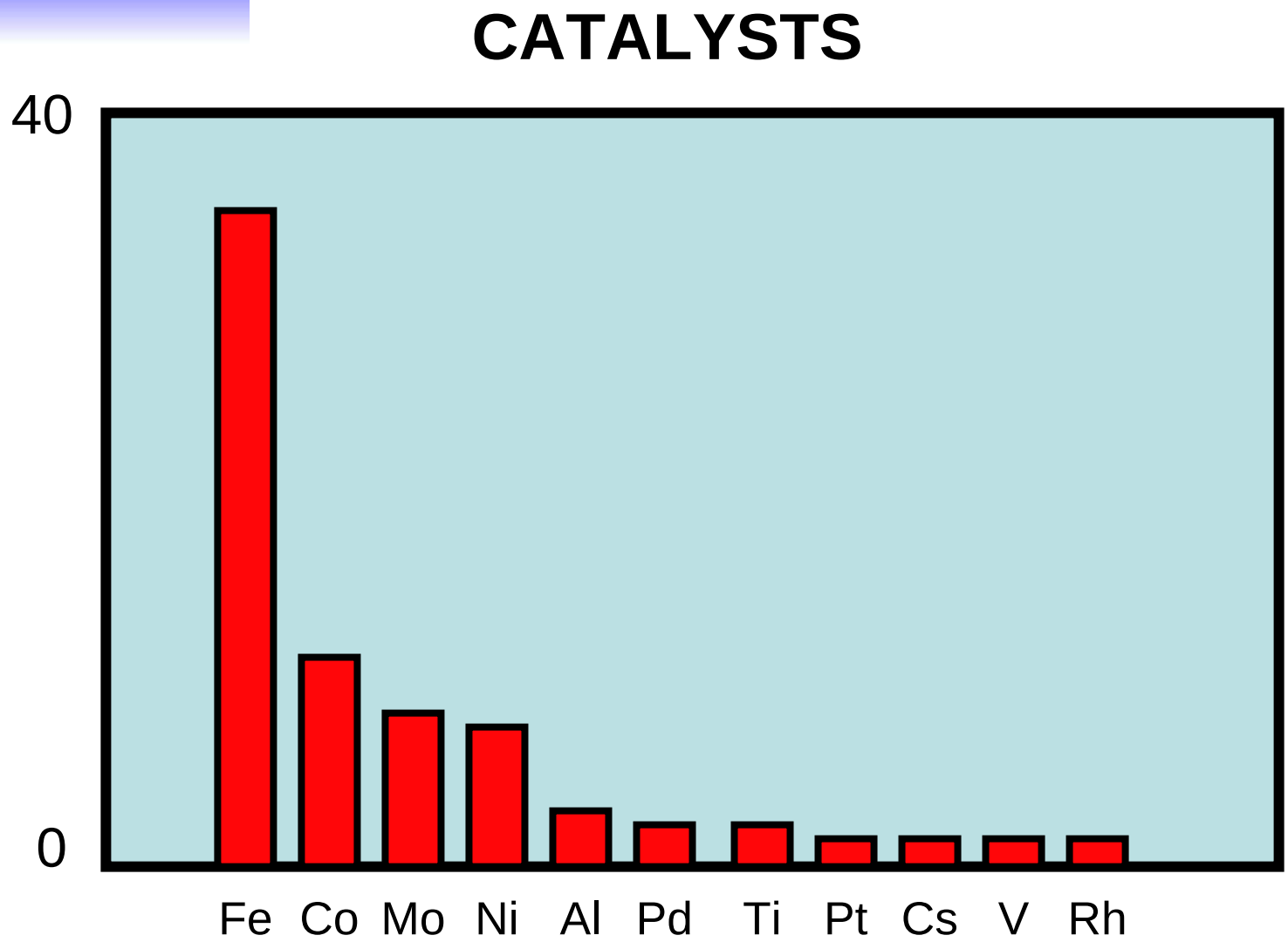
Poster Session A: Synthesis

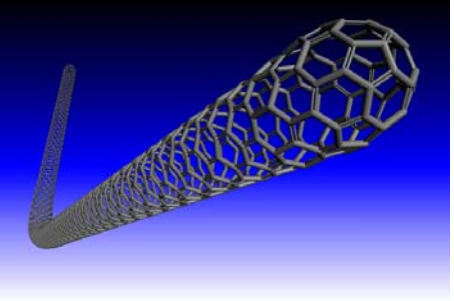
SUBSTRATES





Poster Session A: Synthesis

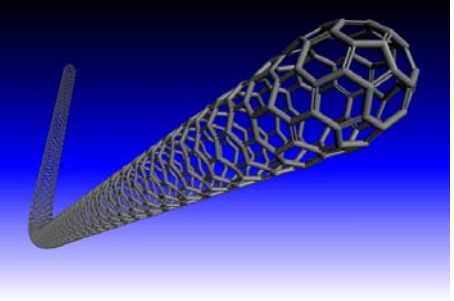




Poster Session A: Synthesis

HYDROCARBON FEEDSTOCKS

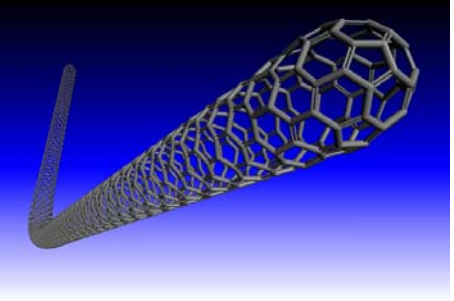
C_2H_5OH		10
CH_4		8
C_2H_4		7
CO		6
C_6H_{14}		3
C_2H_2		2
C_2H_6		1
$C_{10}H_{16}O$	(Camphor)	1



Poster Session A: Synthesis

TUBE TYPES

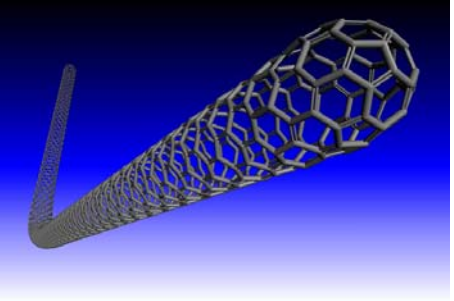
Multi Wall	20
Single Wall	34
Double Wall	6



Poster Session A: Synthesis

Four THEORY / MODELLING PAPERS

A13/A14	**Curtarolo et al**	MD and physics melting, G-T eq
A52	**Hirama et al**	MD role of oxygen, stops shells
A56	**Nasibulin et al**	Specific mechanism for tube formation. (penta/hepta gons)
A60	**Bichara et al**	MC carbon adsorbed at surfaces of Ni particles



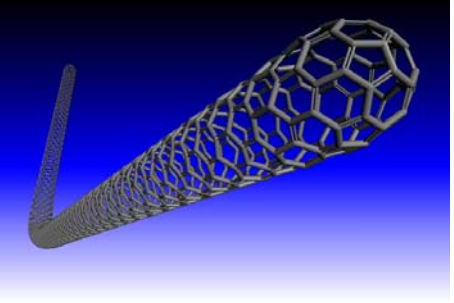
Poster Session A: Synthesis

Technique development to improve understanding

A12	**Svrcek et al**	Growth on microbalance
A29	**Hart and Slocum**	Upthrust of growing carpet
A47	**Chiashi et al**	In situ Raman, incub. time
A48	**Arcos et al**	In situ PES, cat. ox. states
A65	**Hart and Slocum**	Combinatorial in microchannels

But no papers here on in-situ HR TEM ?

(S Helveg et al, Nature 427, 426, 2004)

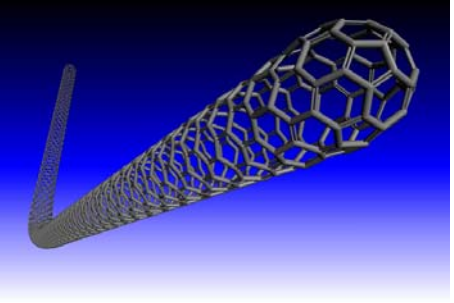


Poster Session A: Synthesis

Experimental (a): Control of SWNT diameter

A56 (e.g.)Nasibulin et al	Controlled by catalyst diameter
A23 Jeong et al	Catalyst diameter - no effect
A21 Inoue et al	Controlled by alloy elements in catalyst
A24 Saito et al	Controlled by composition of feedstock

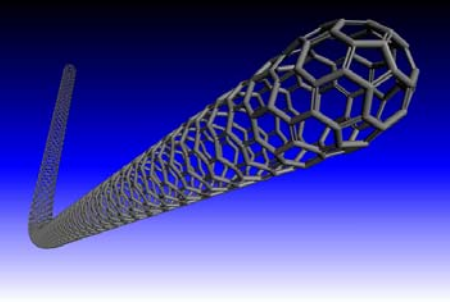
Who is right ? All ? Visit these posters



Poster Session A: Synthesis

Experimental (b): Some interesting chemical variants

A37	**Kumar et al**	Camphor works v. well for MWNTs
A21	**Inoue et al (again)**	Subst. (+Co) of Rh & Pd for Fe & Ni
A9	**Gruneis et al**	^{12}C and ^{13}C isotopes Affects diam. (9)
A11	**Harutyunyan et al**	Writing 'bar code' to follow growth (11)
A45	**Ren et al**	Sulphur affects kinetics, Shown to be in
A 71	**Motta et al**	Fe/carbon interface (71)
A23	**Jeong et al (again)**	Other metal containing proteins than ferritin
A24	**Saito et al (again)**	Metal-containing 'reversed' miscelles
A10	**Esconjauregui et al**	Non transition catalyst metals: Al, Na, Cs !

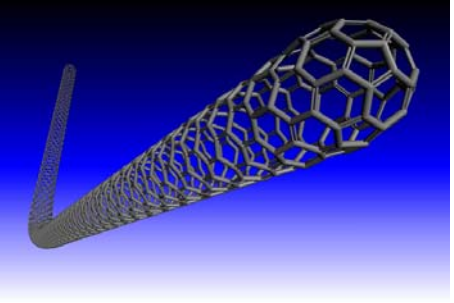


Poster Session A: Synthesis

Experimental (b): Some interesting ...cal variants

A37	**Kumar et al**	Camp... MWNTs
A21	**Inoue et al (again)**	...e & Ni
A9	**Gruneis et**	...s diam. (9)
A11	**Haruty**	...w growth (11)
A45	**Ren et**	...inetics, Shown to be in
A 71	**Motta et**	...terface (71)
A23	**Jeong et al**	...er metal containing proteins than ferritin
A24	**Saito et al (aga...)**	Metal-containing 'reversed' miscelles
A10	**Esconjauregui et al**	Non transition catalyst metals: Al, Na, Cs !

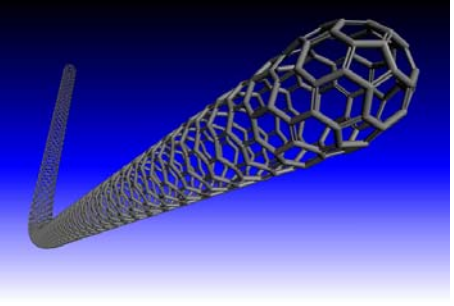
Can we find a few simple underlying principles ?



Poster Session A: Synthesis

Experimental (c): First stage assembly at synthesis

A01 Mueller et al **A38 Borrowiak-Palen et al**	Filling MWNTs with Fe, Co, Ni (01) and SWNTs with Ag, Fe etc. (38) (n.b. posters (b).
A05 Yoo et al **A57 Hayashi et al**	Control and enhancement of vertical alignment from substrates.
A34 Ago et al	Horiz alignment on ‘A’ face sapphire
A68 Moisala et al **A70 Motta et al**	Direct spinning of high performance fibres from CVD reaction.
A08 Na et al **A29 Hart and Slocum** **A39 Weng et al**	Patterning of vertical growth (8), patterning into a micromould (29), on tips of Si nanostructures (39)



Poster Session A: Synthesis

Experimental (c): First stage assembl[illegible] synthesis

A01 Mueller et al
A38 Borrowiak-Palen et al
Fill[illegible] Fe, Co, Ni (01) and etc. (38) (n.b. posters (b).

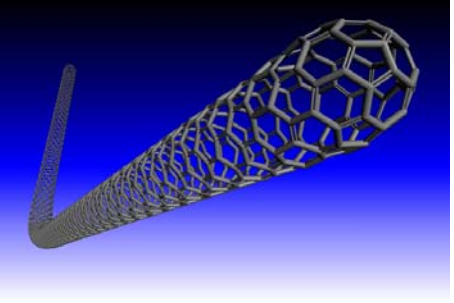
A05 Yoo et al
A57 Hayashi et al
[illegible]nt of vertical [illegible].

A34 Ago [illegible]
[illegible] 'A' face sapphire

A68 Moisala
A70 Motta et a[illegible]
[illegible]nning of high performance [illegible]s from CVD reaction.

A08 Na et al
A29 Hart and Slocu[illegible]
A39 Weng et al
Patterning of vertical growth (8), patterning into a micromould (29), on tips of Si nanostructures (39)

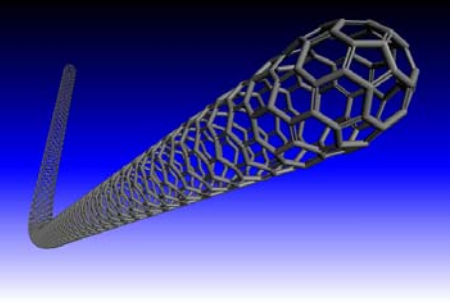
Technology pull ?



Poster Session A: Synthesis

Process Variables:
example of floating catalyst

1. Reaction vessel temperature
2. Reaction vessel design
3. Carrier gas composition
4. Carrier gas flow rate
5. Type of feedstock
   (ethanol, hexane, acetone, ethylene glycol,….)
4. Rate of injection of feedstock
5. Composition of catalyst and precursor type
6. Rate of injection of catalyst
7. Rate of removal of carbon nanotubes (if at all)



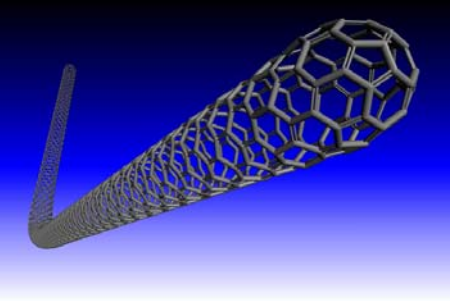
Poster Session A: Synthesis

Process Variables:

example of floating catalyst

1. Reaction
2. Reactio
3. Carrier
4. Carrie
5. Type
   (et ne glycol,….)
4. Rate o
5. Compos sor type
6. Rate of inje
7. Rate of removal nanotubes (if at all)

We are doing technology in multidimensional parameter space !!



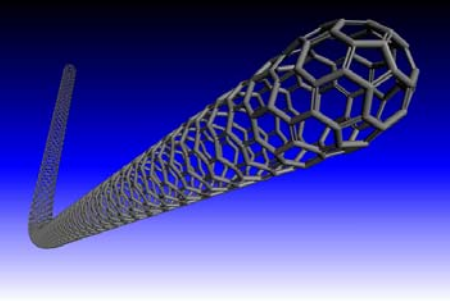
Poster Session A: Synthesis

Five questions of science to answer:

1. **Does surface of metal particle catalyse:**
   (a) decomposition of hydrocarbon
   (b) decomposition of further metal precursor

2. **What is the metallurgy of nano particles ?**
   (a) melting point, surface melting, internal pressure
   (b) carbon solubility (as function of radius)
   (c) phase diagram with carbon, (modelling+experiment)

3. **Does a region of metal particle have to remain free of a graphene coating? If it doesn't, is that a killer ?**



Poster Session A: Synthesis

Five questions of science to answer: (cont)

4. **What determines rate of growth ?**
   - **(a) diffusion rate in metal (surface),**
   - **(b) supply of carbon to particle,**
   - **(c) shape changes due to flow of small (not necessarily molten) particles.**
   - **(d) interface modifiers such as sulphur**
   - **(e) do we have a reliable Ea yet ?**

5. **What determines type and size of nanotube ?**
   - **(a) metal particle diameter and/or composition**
   - **(b) temperature**
   - **(c) feedstock**
   - **(d) what is the difference in growth mechanism between (say) a double wall tube and an 8 ish layer multi-wall tube of similar diameter ?**

Poster Session A: Synthesis