Growth of Carbon Nanomaterials by Chemical Vapour Deposition

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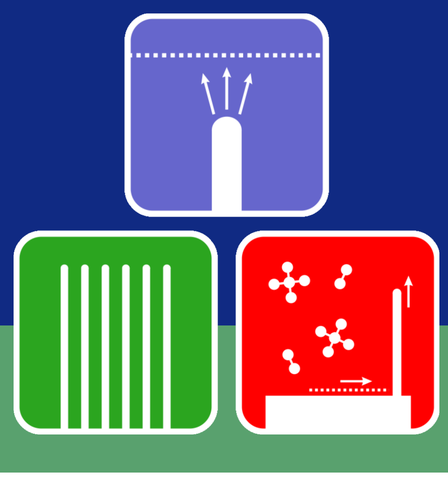


Aims

To synthesise carbon nanotubes (CNTs) using the method of chemical vapour deposition (CVD) and investigate the effects of adjusting the growth environment to maximise the yield and quality. To use photolithography techniques in order to produce the University of Bath logo in CNTs, to help understand potential uses within electronic technology and facilitate device development.

Carbon Nanotubes

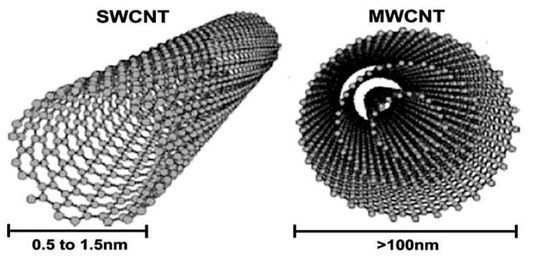
CNTs are tubular structures with dimensions at nanoscale, made purely from covalent carbon interactions. CNTs can be single or multi-walled and they possess desirable properties of high electrical conductivity, semi conductivity, mechanical strength and elasticity, thermal conduction and electron emission.

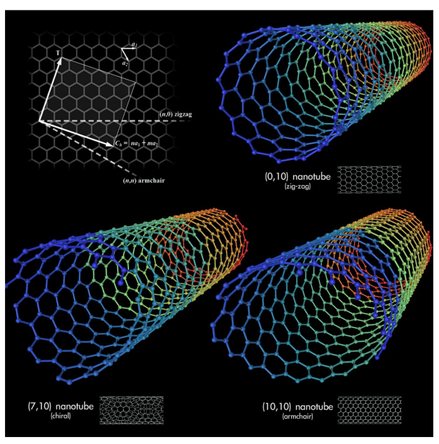
Potential uses:

- Energy storage
- Molecular electronics
- Thermal and structural materials
- Electrical conduction
- Fabrics and fibres
- Civil applications
- Biomedical
- Air and water filtration
- Flexible electronics

CNT properties factored by:

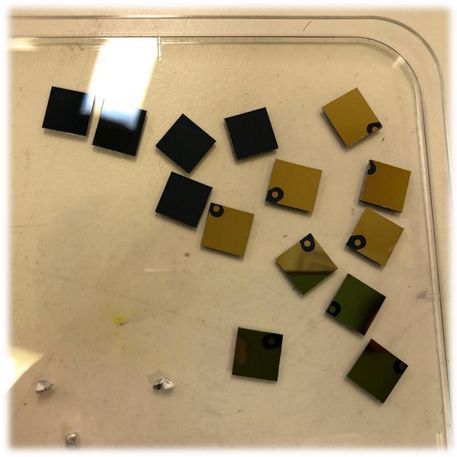
- Chirality
- Length
- Number of walls
- Diameter
- Purity





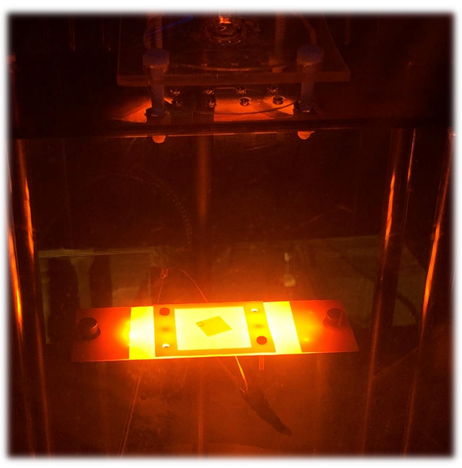
Preparing Catalyst Films - Evaporation

CVD appears to be the most promising method for producing high yield, low cost CNTs due to low temperatures and short growth times. The CVD method requires a catalyst to grow CNTs at these low temperatures. A physical vapour depositor was required to fabricate an aluminium buffer and iron catalyst onto a silicon based substrate.

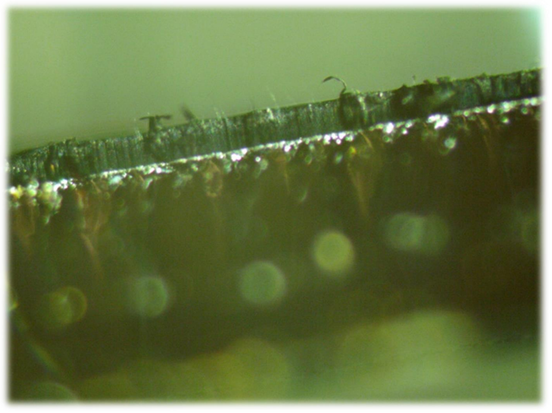


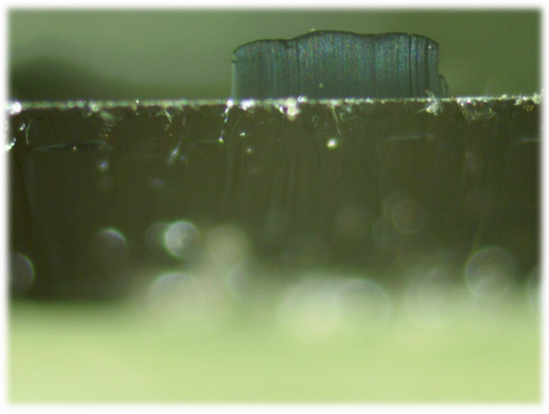
Growing Carbon Nanotubes - CVD

An Aixtron Black Magic Chemical Vapour Deposition (CVD) reactor in 3W1.5a was used to grow CNTs upon the fabricated catalysts, using a mixture of carbon containing acetylene, hydrogen gases and heat.

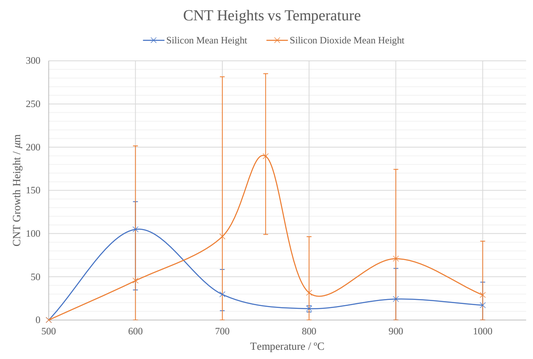


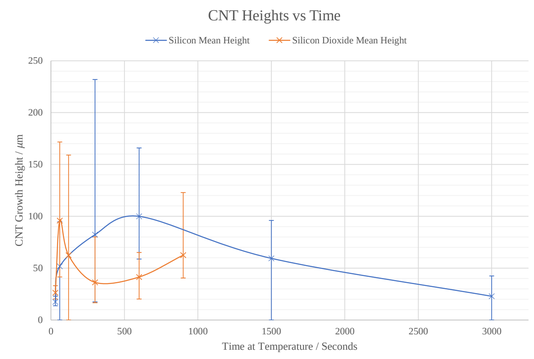
Results

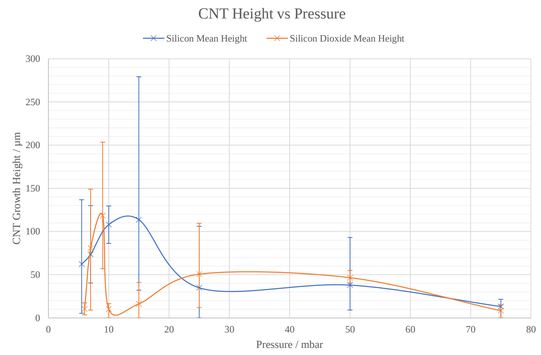


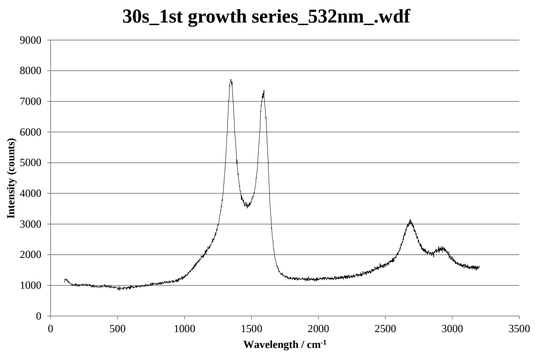


Growth heights of every sample were measured using a microscope and compared to the conditions of time, temperature and pressure varied in the CVD chamber.



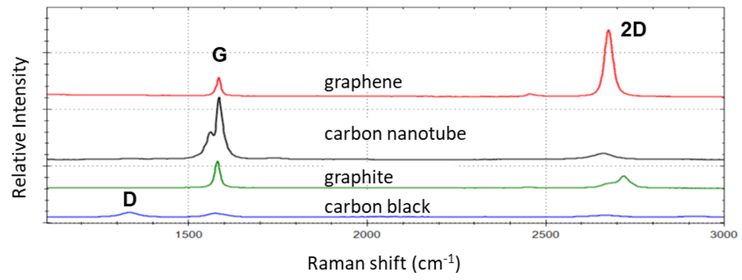






Analysis

Comparing results from Raman spectra with results from other CNT experiments helped to conclude that CNTs were produced and not any other allotrope of carbon.



The data collection enabled observations to be made about the most favourable conditions for growth of CNTs, which was estimated as 600s, 750℃ and 10 mbar.

Further Research

Now that all the facilities at the university are functioning and able to grow CNTs, a larger emphasis on data collection and analysis can be placed in further experiments. More focus can be placed onto the factors affecting the growth mechanism and develop a recipe with optimal growth conditions for CNTs, progressing research of CNTs and furthering their advance into electrical applications.

The CVD reactor also has the capability to grow graphene using similar techniques, which can also be researched and explored into their applications.

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