CARBON NANOTUBES

& THERMOSET POLYMERS

Quantum
MATERIALS

The Core Team

- Naga Prasad, MBA, Monash University, Australia
  - Managing Director
- Srinivas Magadi, B.Sc, Bangalore University
  - Chief Executive Officer
- Dr. Satheesh Kumar, Ph.D, University of Mysore
  - Post Doc at University of Guelph, Canada and National University of Malaysia
    - Chief Research Officer

QUANTUM MATERIALS

- QUANTUM MATERIALS is a Bangalore based Nanotechnology company which was founded in 2009 with strong focus on Research & Development in Nanomaterials and Master Batches.
- QUANTUM MATERIALS (soon to be renamed) is working with many companies on new product development programs with our scientists around the world.

Value Chain

- Quantum's core business

Metals	Packaging
Polymers	Batteries
Ceramics	Rubber
Fertilizers	Concrete
Defense	Electronics

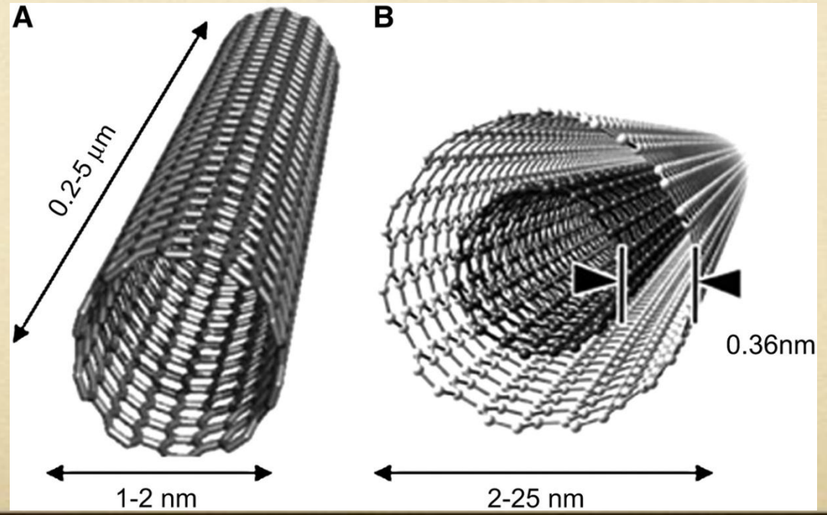
KANVA QUANTUM NANOTECH LTD

- Quantum Materials has formed a Joint Venture with bangalore based KANVA GROUP (www.kanvagroup.com) a 300 Crore group of companies.
- In the process of changing the name to Kanva Quantum Nanotech Ltd.
- Kanva Quantum will be in production of MWCNT, Graphene & Master Batch facility by October 2013 with total production capacity of 100 tons per annum.

QTubes

Multi Walled Carbon Nanotubes in Thermoset Polymers

- Dr. Satheesh Kumar, PhD



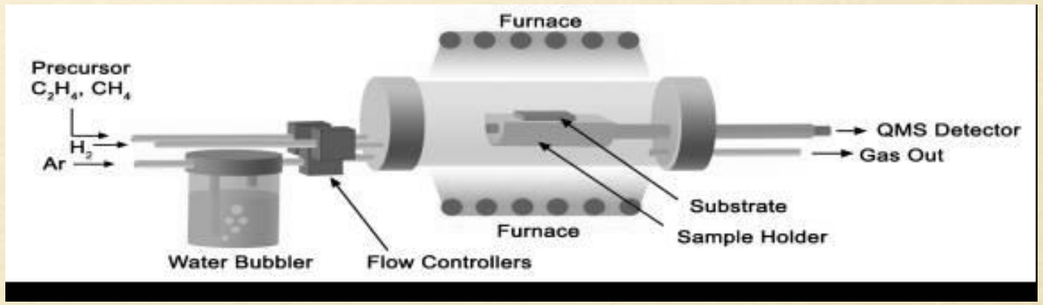
Advantages of CNT

- Many folds (5x) stronger than steel
- Harder than diamond
- High electrical conductivity than copper
- High thermal conductivity than diamond

Prerequisites of CNT for thermoset composite applications

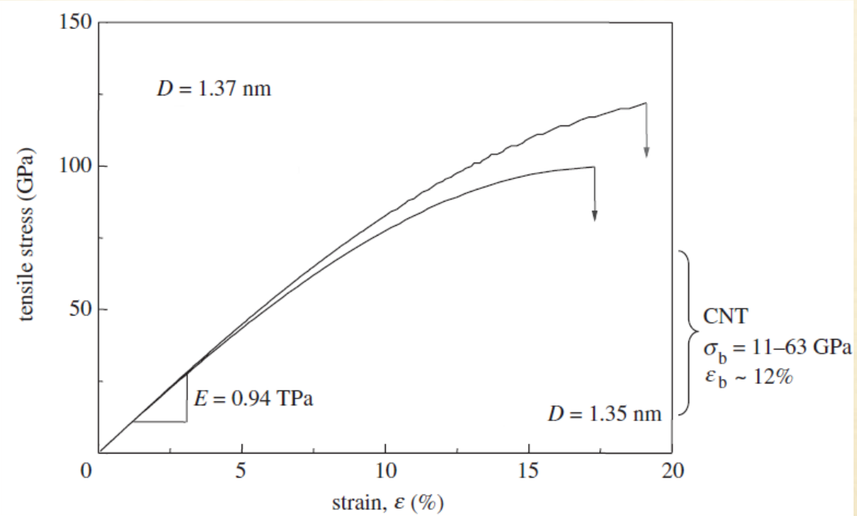
- High aspect ratio
- Large surface area
- Low density
- High Purity
- High Yield
- Functionalization

•CVD Reactor – CNT Manufacturing

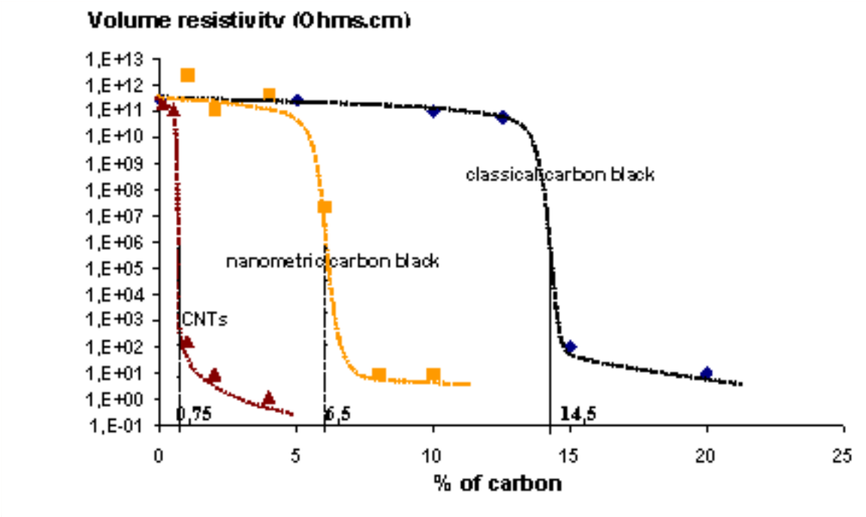


Why CNTs in Composites?

To enhance the properties of the resultant product for specific application



- Mechanical properties – Good
- Larger Stress–Strain Response
- Stress transfer characteristics – Good – Structural Applications



- Electrostatic dissipation properties – remarkable even at low concentration of CNT compared to traditional fillers

CNT Based Thermoset Composites

Applications

- Wind Mill Blade
- Automobile & Aerospace Parts
- Bicycle Frames
- Tennis Rockets
- Baseball Bats
- Golf Clubs
- Hockey Sticks
- Skis

Evaluation of QTube Reinforced Epoxy Composite for Tribological Wear Behaviour

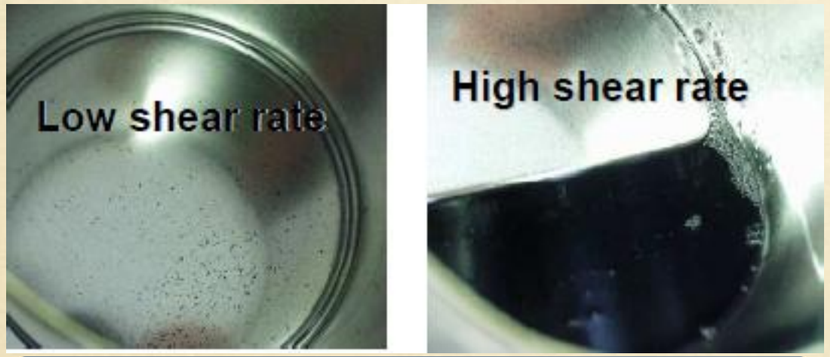
- Test Parameters

- Load – 30, 60 & 90 N
- Speed – 200 rpm
- Wear Track Dia – 50mm
- Test condition – Dry
- Environment – 47.5% RH and 33^{0}C
- Test Duration – 4 days
- Instrument used – Wear & Friction Monitor TR 20L, Ducom, Bangalore

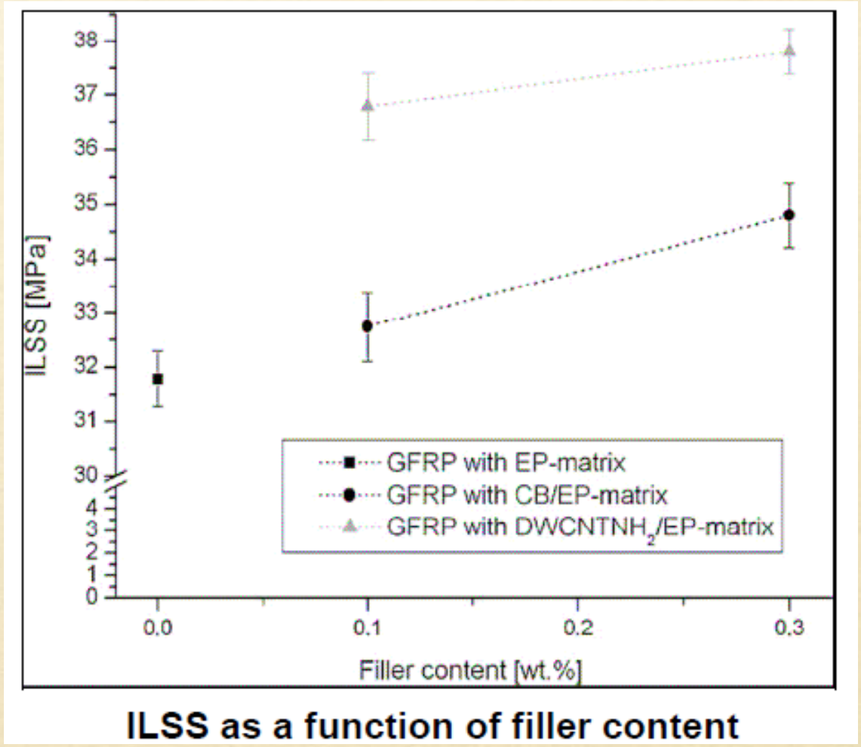
Sample	Load in N	Mass loss (g)
Epoxy - Neat	30	0.003
	60	0.083
	90	0.156
1.25% CNT	30	0.002
	60	0.004
	90	0.083
5% CNT	30	0.001
	60	0.188
	90	0.142

1.25% is the optimised dosage to have the reinforcing effect.

CNT and Epoxy Mixing



Effect of shear on mixing of CNT in epoxy resin



ILSS as a function of filler content

CNT enhanced Polymer Composite for Space Applications

- CFRP Composite based on CNT – Epoxy for a maximum service temperature of 150^{0}C
- CFRP Composite based on CNT – Cyana tester for a maximum service temperature of 300^{0}C

Manufacturing process: Preparation of prepregs by application of an industrial process of infiltration of carbon fabric by modified CNT-cyanate ester / epoxy resin.

QPoxy®

- CNT reinforced Epoxy

QTubes + Epoxy

- Q Tubes (12nm) were dispersed in Araldite CY 230-1 EPOXY resin.
- Q Tubes dispersed EPOXY nanocomposites are suitable for composites, adhesives and coatings applications.

Samples

- Qtubes dispersed in Epoxy - ARALDITE CY 230-11 in following concentration

1.Neat Epoxy

2.QTubes + Epoxy – 0.1

3.QTubes + Epoxy – 0.5

4.QTubes + Epoxy – 1.25

5.QTubes + Epoxy – 2.5

6.Qpoxy® – 5

Conclusion of wear and friction test

505% increase in wear resistance

Wear performance best shown by Q Tubes in Epoxy with 1.25% CNT which is 5 times higher for wear and friction performance.

TENSILE STRENGTH TEST

Samples

- Qtubes dispersed in Epoxy - ARALDITE CY 230-1 in following concentration

1.Neat Epoxy

2.QTubes + Epoxy - 0.1

3.QTubes + Epoxy- 0.5

4.QTubes + Epoxy- 1.25

5.QTubes + Epoxy- 2.5

Conclusion

- 1.25% CNT dose found to be optimized to get an improvement of 396%

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- We would be open to collaborate for new Composite applications

- THANK YOU