CARBON NANOTUBE COMPOSITES WITH CHEMICALLY FUNCTIONALIZED PLANT OILS

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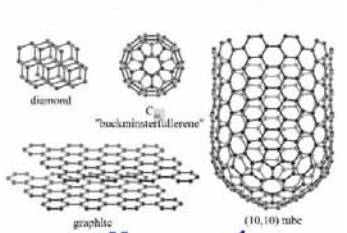
Objective and Motivation

The effect of carbon nanotubes on mechanical properties of plant oil based polymer is being investigated.

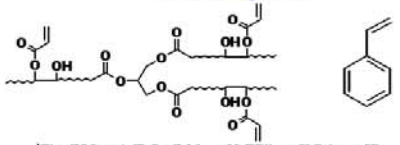
Carbon nanotubes (CNT) have the potential to significantly enhance the mechanical properties of plant oil based polymers. The modulus and strength of CNT's has been reported to be ~1 TPa and 450MPa respectively compared to polymer modulus and strength of 1 GPa and 60 MPa. Plant oil based polymers have chemical structure similar to polymers in successful CNT-polymer composites, such as Polyvinyl Alcohol.

Carbon Structures



Monomers[1]

Acrylated Epoxidized Soybean Oil (AESO) + 35 wt % styrene



[1]Khot SN, Lascala JJ, Can E, Morye SS, Williams GI, Palmese GR, Kusefoglu SH, Wool RP, *Development and application of triglyceride-based polymers and composites*, J Appl Polym Sci, 82 (3), 2001

CNT Dispersion in Monomer Mixture

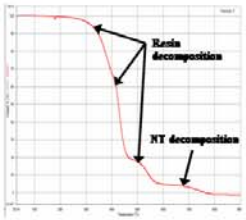
Sonication → NO dispersion
Immediate evaporation of styrene

Mechanical stirring → Magnetic stir bar on stir plate
Dispersion stable for weeks

wt% NT	Stir time needed for dispersion
1	~48 hours
3	~48 hours
5	~72 hours

Thermogravimetrical Analysis

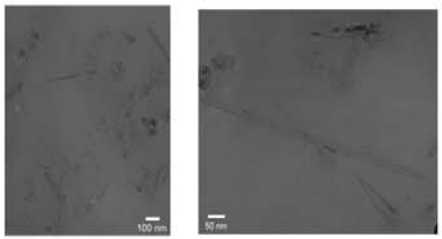
Determination of NT amount in polymerized sample after 48 hour sedimentation of NT-monomer dispersion



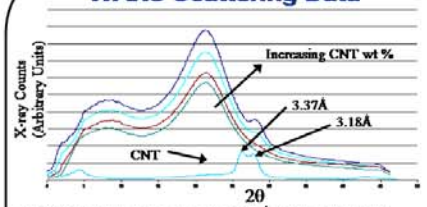
Wt% NT in monomers	Wt% NT in polymer
1	0.2*
3	1.8
5	4.36

*inaccurate due to low NT content

TEM of Polymerized Resin-NT Composites



WAXS Scattering Data



- CNT peak corresponding to 3.37Å is the inter-wall distance in a single MWNT and is masked by the amorphous halo in the composite samples.
- Peak corresponding to 3.18Å appears in all composites. Stable hexagonal packing of CNTs has been theoretically and experimentally determined to be 3.14Å

Conclusions

- Significant mechanical improvement at 1wt% carbon nanotubes in plant oil based resin:
  - Modulus +30%
  - T_g +13%
- Limited amount of NT's sediment from monomer mixture over 48 hour sedimentation period (TGA)
- CNT bundles appear in higher weight % composites
  - Could be present in dispersion, or form during polymerization

Acknowledgements

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