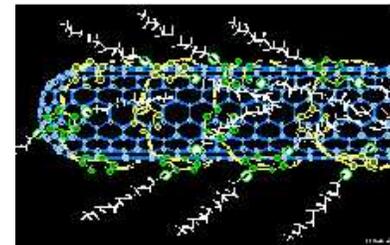




## Integrating Carbon Nanotubes for Advanced Materials

### *Stronger, tougher thermoset and thermoplastic composites*

Eltron Research & Development has developed polymers of unprecedented strength and toughness by creating composites of epoxy and single-walled carbon nanotubes (SWNTs). The result is a strong, lightweight, non-corrosive, solvent-resistant material with desirable mechanical, electrical and thermal properties. With only 1% loading, the epoxy strength can be increased by 45% or more; the toughness can be increased by 100% or more. In addition, Eltron's SWNT composites do not suffer from the same delamination issues that plague other carbon fiber composites.



*SWNT with the polymer PmPV wrapped around its outer surface. The side chains protruding from the nanotube's surface are being modified to chemically bind with the epoxy precursors during curing of the composite.*

#### **Benefits**

- Drastically improved strength and toughness
- Desirable electrical and thermal characteristics
- Lightweight
- Does not delaminate like other carbon composites

#### **Applications**

Carbon nanotubes (CNTs) are the strongest materials currently known. CNTs also possess thermal and electrical characteristics that are uniquely suited to many applications.

- Developing ultra-high-strength composites for a variety of applications such as ballistic material, aerospace, specialty equipment, etc.
- Reinforcing and imparting desirable electrical and thermal conductivity properties into thermoset and thermoplastic composites
- Eliminating delamination, on the molecular scale, the bond between carbon fiber and epoxy matrix interface in carbon fiber composites
- Producing non-corrosive, solvent resistant, lightweight, conductive materials for body panel and fuel line applications

### The Technology

Eltron has successfully incorporated SWNTs into polymeric materials by circumventing the issue of insolubility, a characteristic of CNTs that has been an insurmountable technology challenge. To accomplish this, we use the polymer poly(m-phenylenevinylene-co-2, 5-dioctoxy-p-phenylenevinylene) (PmPV) to function as an interfacial bridge between the SWNTs and the material in which the tubes are being dispersed.

The tendency of the polymer backbone in PmPV to adopt a helical configuration acts to promote the winding of the polymer around both individual SWNTs and multiple SWNT ropes. The interaction between the PmPV and SWNTs is purely mechanical, so there is no incursion into the bond structures of the SWNTs. Attaching various functional groups to the side chains of the PmPV polymer makes covalent bonding possible between the composite reinforcement (the PmPV/SWNT) and the final composite's matrix.

### Stage of Development

Today, Eltron researchers have successfully:

- Developed PmPV-coated, single walled carbon nanotubes
- Achieved 1% loading in epoxy resulting in 45% increase in strength and a 100% increase in toughness
- Identified means by which to functionalize the side chains for greater dispersion (not yet tested), which should result in a significant, further improvement in strength

Ultimately, Eltron wants more funding to develop the methods for functionalized PmPV coated SWNTs to provide order of magnitude performance improvements to epoxies.

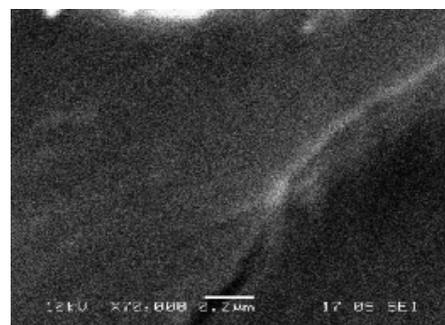
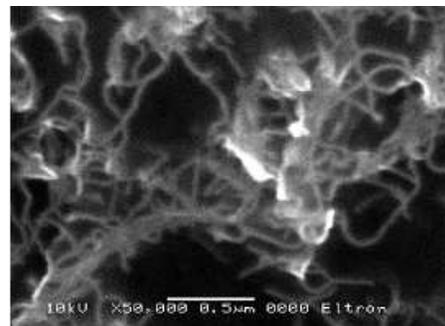
Until then however, Eltron can provide *unfunctionalized* PmPV coated SWNTs to provide great performance improvements to current composite technologies such as improving the shear strength of carbon fiber composites.

Eltron has an issued US patent: 7,411,019, *Polymer Composites Containing Nanotubes*.

The technologies described, and all related inventions are owned by Eltron Research & Development Inc, and protected by copyrights, trademarks, issued and pending patents, trade secrets, or other applicable intellectual property rights.

### Contact Us

To discuss the possibility of entering into a business relationship with Eltron, contact the Business Development Group at [business@eltronresearch.com](mailto:business@eltronresearch.com).



SEM micrographs of the fracture surfaces of cured epoxies with SWNT by themselves (top) and with a PmPV/SWNT mixture (bottom). The SWNTs by themselves decrease the strength of the composite relative to the neat epoxy while the PmPV/SWNT reinforcement increases the strength.



**Eltron Research & Development Inc.**

Eltron Research & Development commercializes novel technologies involving energy, chemicals, advanced materials and environmental systems.