

Description

ZNT-C[™] is a polymer modified multi-wall carbon nanotube additive that can be used for reinforcing thermoset and thermoplastic resins, polymer fiber reinforced composites, coatings, and adhesives. The polymer modification makes these multi-wall carbon nanotubes easy to disperse resulting in significant improvements in mechanical properties for a wide range of applications for composites and coatings. Additionally, the ZNT-C will remain uniformly dispersed for extended periods of time.

ZNT-C can be mixed into a variety of thermoset resins including epoxy, vinyl ester, polyesters, polyurethanes, polyureas and other polymers. Depending on the formulation characteristics, typical final ZNT-C loadings should range from 0.1 to 1.0-wt %. This loading percentage is intended for mechanical property improvements and targeted performances. In some cases, it may be required to modify the resin formulations and/or curing agents to achieve the benefits of ZNT-C. In some applications, such as modifying thermoplastic polymers (such as polycarbonate, nylon and others), ZNT loadings of 1-10 wt. % may be necessary to achieve mechanical property improvements. ZNT-C can be readily dispersed into monomers through sonication or a high shear mixing process. In situ polymerization of the monomers with ZNT-C can also form superior dispersions in the resulting MWNT-polymer composites. At high ZNT-C loadings, electrical surface resistivity of 10^8 - 10^{10} ohm/square, or lower, can be achieved.

ZNT-C is easily dispersed into solvents such as methyl ethyl ketone (MEK), acetone, N-methyl pyrrolidone (NMP), chloroform, and dichloromethane using high shear mixing and/or sonication. Solvent dispersed ZNT-C can readily be made into Buckypapers through conventional processes.

In addition to ether functionalities, ZNT-C has aromatic ester groups that are amenable for further chemical manipulation. Saponification of the ester functionalities will liberate carboxyl groups that can further be post functionalized with other chemical moieties to modify the surface functionalities of MWNT.

Mixing Procedure

ZNT-C is a polymer modified multi-wall carbon nanotube powder that is easily integrated into a wide range of thermosets and thermoplastics. The following mixing procedures typically produce the best results:

Solvent dispersions:

Accurately weigh 100-400 mg ZNT-C per 100 ml solvent and process the materials using water bath sonicator or probe sonicator at 50-60 watts of power. Alternatively, high-shear mixing can be used in making solvent dispersions. When using high-shear mixing, typically 4000 - 6000 RPM is required. Both sonication and high-shear mixing processes result in generation of heat. However, keeping the contents at temperatures below 10°C will reduce the processing times and improve the quality of dispersions. ZNT-C contains a slight excess of a proprietary polymer (non-covalent functionalizing agent). The excess

polymer aids the easy dispersion of MWNTs into solvents. During the first few minutes of the sonication or high-shear mixing process, the ZNT-C suspension may have a slight fluorescence color. The suspension gradually becomes black with continued processing. Applications that need a high dispersive state of ZNT-C in solvents may require an ultra-centrifugation process after the initial dispersion. ZNT-C solvent suspension may be centrifuged at 3000 - 4000 RPM for 30 minutes (depending on the specific centrifuge) to remove larger agglomerates as needed.

Dispersion into thermoset resins:

ZNT-C can easily be dispersed into viscous thermoset resins by three-roll milling, high-shear mixing, and/or a sonication process. Alternatively, a ZNT-C solvent suspension may be mechanically mixed under low shear or mechanical agitation followed by the evaporation of the solvent under vacuum.

Dispersion into thermoplastic polymers:

For thermoplastic applications, a twin-screw extrusion process, through the control of extrusion variables such as barrel temperature, feed rate, screw speed, and different screw configurations will result in different dispersive states of MWNTs within thermoplastic resins.

Safety Handling

Zyvox Technologies provides its customers with a product-specific Material Safety Data Sheet (MSDS) to cover potential health effects, safe handling and use information. Zyvox encourages its customers to review all relevant MSDS prior to use.

Disclaimer

Zyvox Technologies believes that the technical data provided is accurate as of the published date. Performance values and the material specifications are considered representative but are not intended as a specification and may vary slightly from lot to lot of product.

Material Specifications

Table 1: ZNT-C Specification

Characteristic	Unit of Measure	Value	Method of Evaluation
Carbon content	wt%	90	Elemental
Functional chemistry	wt%	13 - 18	TGA
CNT outer diameter	Nanometer	10-15	Arkema *
CNT length	Microns	0.1-10	Arkema *

*Properties established by the MWNT supplier

*Other CNT manufacturers may be used upon request or at Zyvox Technologies' discretion

Table 2: Material Characteristics

Characteristic	ZNT-C
Color	Black
Nanomaterial	Multi-wall carbon nanotubes
Appearance	Powder
Total Solids, weight %	100%
Shelf Life	12 months
Typical loading level as weight%	0.5% - 10%

Table 3: Particle Size Analysis Verification and Surface Area Inspection

Characteristic	ZNT-C Data
Single Point Surface Area	133.94 m ² /g
BET Surface Area	143.5 m ² /g
Langmuir Surface Area	227.8 m ² /g
BJH Adsorption Surface Area	232.4 m ² /g
Single Point Adsorption Pore Volume, less than 40 nm in Diameter	0.461 cm ³ /g
BJH Adsorption Cumulative Pore Volume of pores between 1.7 and 300 nm	0.461 cm ³ /g
Adsorption Average Pore Diameter	12.8 nm

Figure 1: Particle Size Analysis: Dynamic Light Scattering of ZNT-C in DI Water

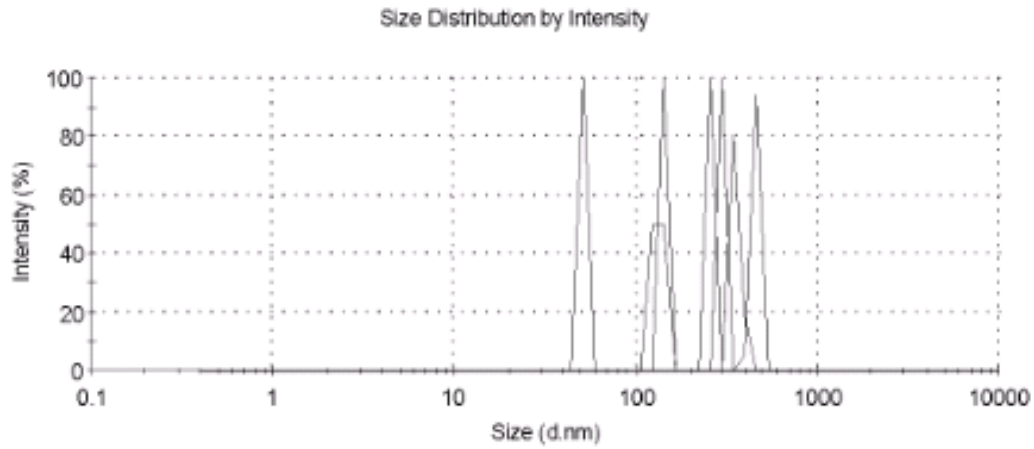


Figure 2: SDT of ZNT-C at 10°C/min in Argon

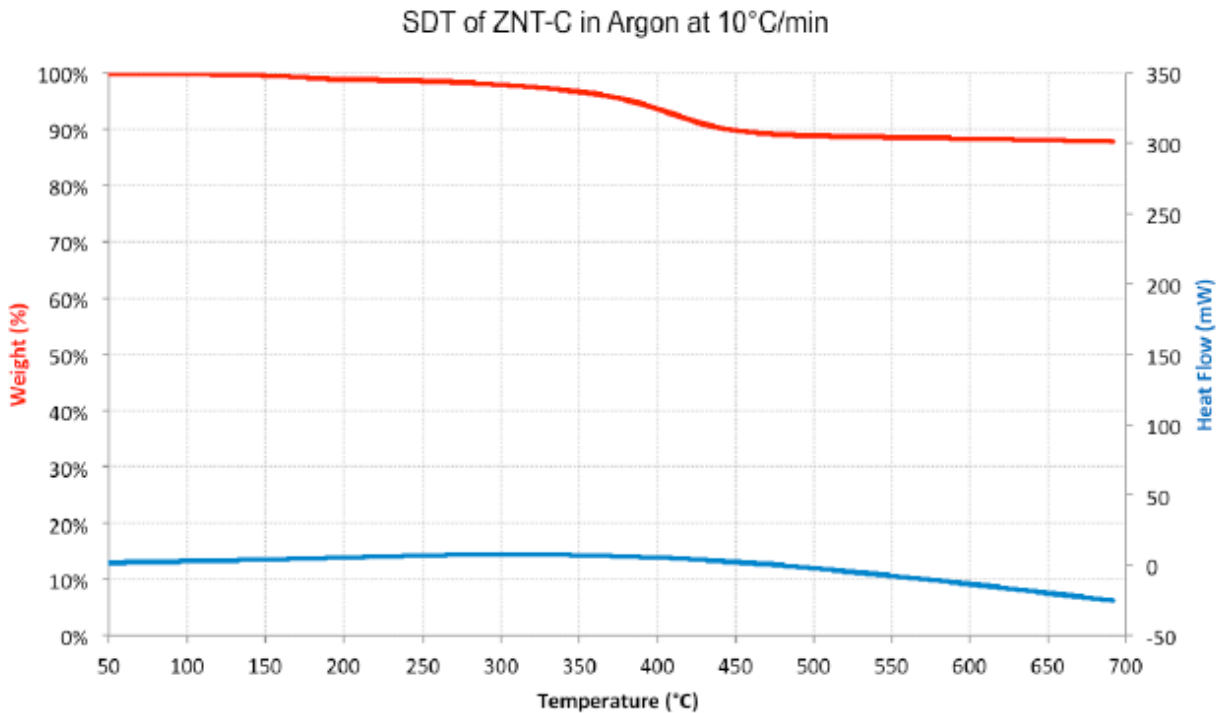
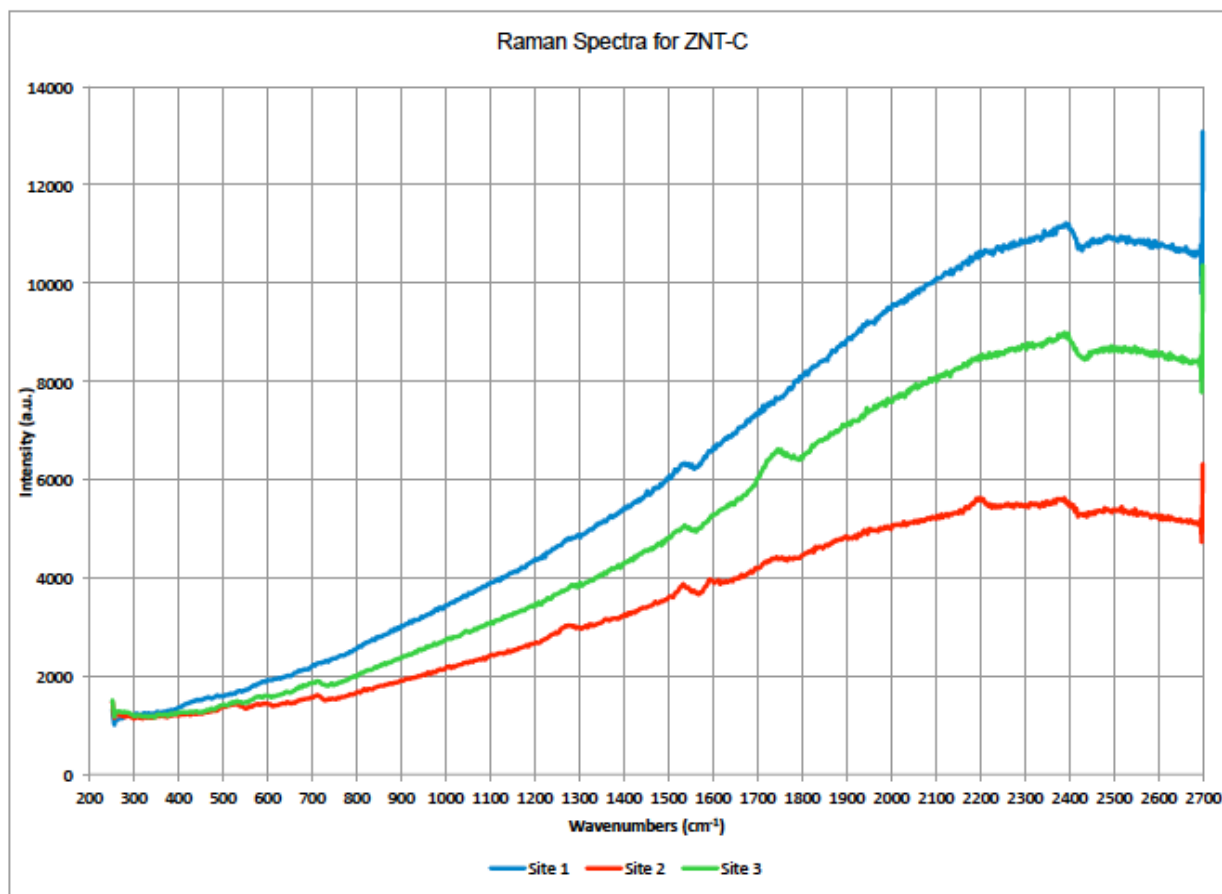


Figure 3: Raman spectrograph of ZNT-C



Contact Zyvex

For United States quotes, orders and product information call toll free 877.Go.Zyvex (877.469.9839).

For international quotes, orders and product information call 614.481.2209.

For Sales & Technical Services call 614.481.2209.

For Health & Safety call 614.481.2209.

Global Headquarters

1255 Kinnear Road, Suite 100

Columbus, Ohio 43212-1155

info@zyvex.com

Visit Zyvex at www.zyvex.com for additional information.