ZNT-Es
Zyvex Nanotube Technology

Technical Data Sheet January 2015

Description

ZNT-Es™ is a polymer modified multi-wall carbon nanotube additive that can be used for reinforcing elastomers that are sulfur cured. The polymer modification on these multi-wall carbon nanotubes makes them easy to disperse and cross link into the host matrix resulting in improved mechanical properties for a wide range of applications including gaskets, o-rings, seals, tires, and shock absorption.

ZNT-Es can be mixed into a variety of elastomeric resins including ethylene propylene rubber (EPDM/EPM), nitrile rubber (NBR), natural rubber (NR), styrene - butadiene rubber (SBR), chloroprene rubber (CR), acrylic rubber (ACM), and hydrogenated nitrile butadiene rubber (HNBR), that are cured by vulcanization. Depending on the formulation characteristics, the typical final ZNT-Es loadings in the formulation range from 1 -10 phr for mechanical property improvements. ZNT-Es can be readily dispersed into rubber formulations using an open mill and/or internal mixers. ZNT-Es loadings of 5 -10 phr provide for electrical surface resistivity of 10^8-10^9 ohm/square or lower values. Thermal conductivities improvements may also be achieved using ZNT-Es. Typical mechanical improvements include increases in tear strength, tensile modulus, rapid gas decompression, and shear strength.

Mixing Procedure

ZNT-Es is a polymer modified multi-wall carbon nanotube powder that is easily integrated into a wide range of sulfur-cured elastomers. The following mixing procedures typically produce the best results:

Dispersion into elastomer compounds:
Solvents are generally not required to achieve uniform dispersion of ZNT-Es into rubber or elastomer compounds. Conventional processing equipment such as open mills and internal mixers are adequate for achieving uniform dispersions. As a general rule, fillers such as carbon black or silica should be added after dispersing the ZNT-Es into the rubber compounds. Plasticizers such as castor oil, paraffin oil, and others can be used as carriers for incorporating ZNT-Es into rubber formulations. For applications that need to solvate rubber, ZNT-Es can be readily introduced using mechanical mixing followed by evaporation of solvent at ambient or low pressures. High shear mixing or sonication process can also be used in lieu of mechanical mixing.

Solvent dispersions:
Accurately weigh 100-400 mg ZNT-Es into 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 also be used in making solvent dispersions. When using high-shear mixing, typically 4000 - 6000 RPM is needed to disperse ZNT-Es into solvents. Both sonication and high-shear mixing processes result in generation of heat, therefore keeping the contents at temperatures below 10°C will typically reduce the processing times and improve the quality of the dispersions. ZNT-Es is associated with a slight excess of a proprietary polymer (non-covalent functionalization agent). The excess polymer aids the dispersion of functionalized MWNTs into solvents. During the first few minutes of sonication or high-shear mixing

process, the ZNT-Es suspension may have slight fluorescence color. With additional processing time, the suspension will gradually become black. Applications that need a high dispersive state of ZNT-Es in solvents may need to follow up with ultra-centrifugation process. ZNT-Es solvent suspension can be centrifuged at 3000 - 4000 RPM for 30 minutes (depending on the specific centrifuge) to remove larger agglomerates as needed.

Safety Handling

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

Disclaimer

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

Material Specifications

Table 1: ZNT-Es Specification

Characteristic	Unit of Measure	Value	Method of Evaluation
Carbon content	wt%	90	Elemental analysis
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 Zyvex Technologies' discretion

Table 2: Material Characteristics

Characteristic	ZNT-Es
Color	Black
Nanomaterial	Multi-wall carbon nanotubes
Appearance	Powder
Total Solids, weight %	100%
Shelf Life	12 months
Typical loading level in weight%	0.1% - 10%

Table 3: Particle Size Analysis Verification and Surface Area Inspection

Characteristic	ZNT-Es
Single Point Surface Area	99.3 m^2/g
BET Surface Area	105.8 m^2/g
Langmuir Surface Area	167.1 m^2/g
Single Point Adsorption Pore Volume, less than 40 nm in Diameter	0.320 cm^3/g
Adsorption Average Pore Diameter	12.1 nm

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

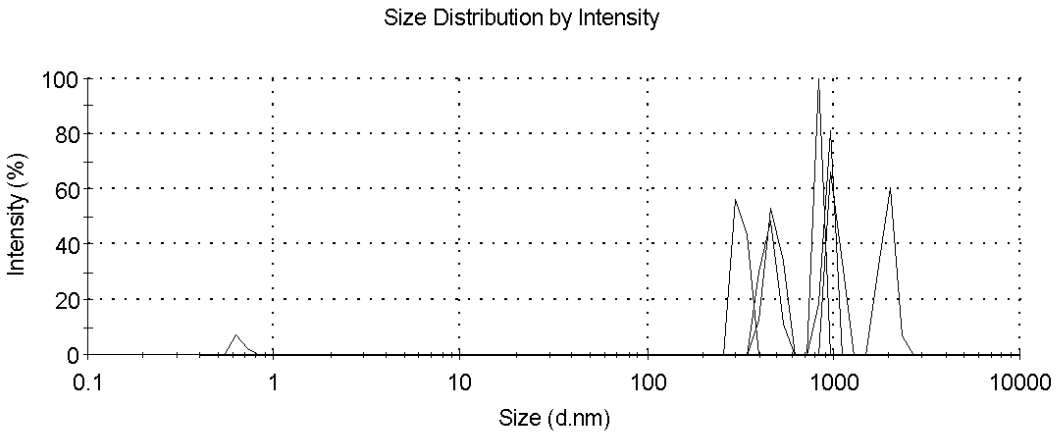


Figure 2: SDT of ZNT-Es at 10°C/min in Argon

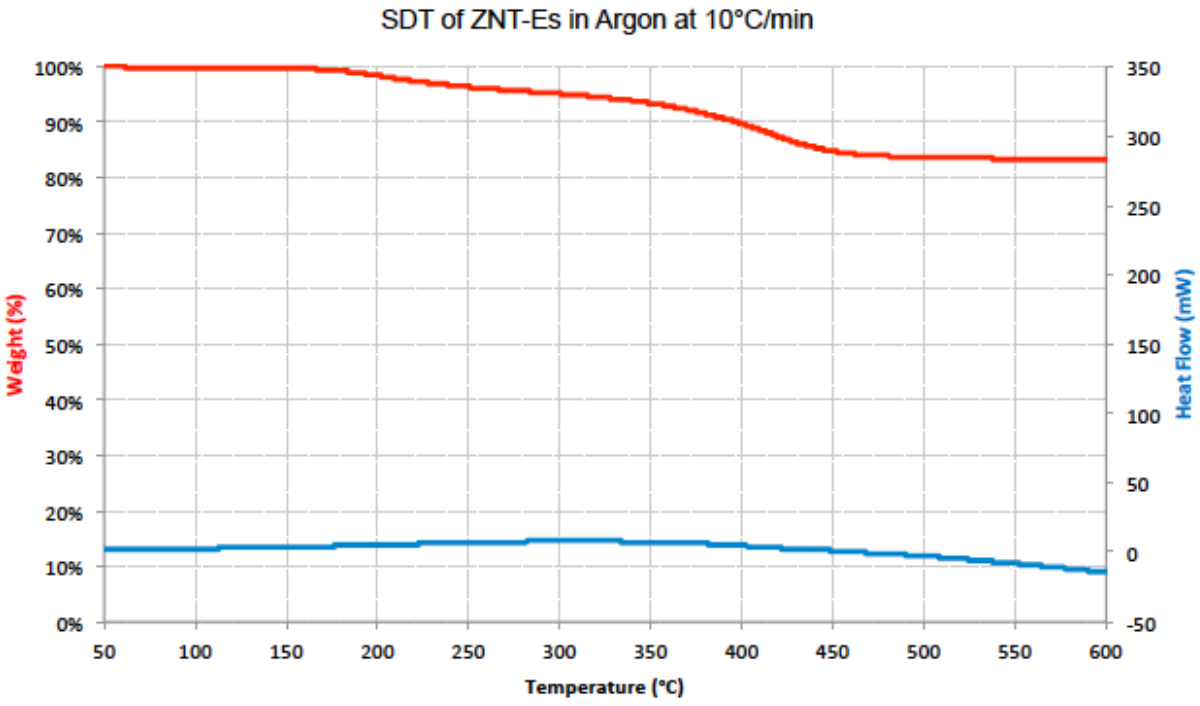
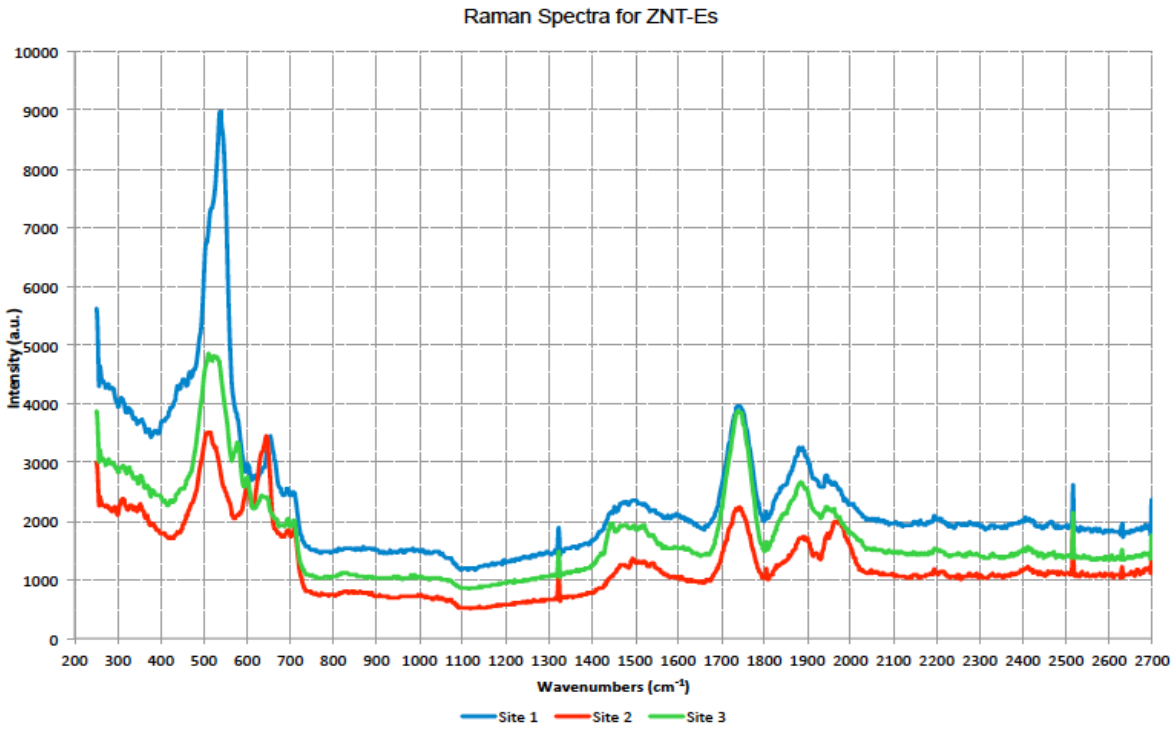


Figure 3: Raman spectrograph of ZNT-Es



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@zyvextech.com

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