

# NC7000™

Multiwall carbon nanotubes

## General Information

### Description

NANOCYL® NC7000™ series, thin multiwall carbon nanotubes, are produced via the Catalytic Chemical Vapor Deposition (CCVD) process.

### Key Applications

A primary interest is in applications requiring low electrical percolation threshold such as high-performance electrostatic dissipative plastics or coatings.

Industrial NC7000™ carbon nanotubes are used in various applications in different markets:

- Transportation (Automotive, Aeronautic, Boats)
- Electronics (Electronic packaging, EMI-shielding, sensors)
- Energy (Lithium-ion)
- Industrial applications (Oil&Gas, dynamic rubber parts, coatings, heating elements)
- Sport goods

### Benefits

- High electrical conductivity
- Good processability
- Retention of key mechanical properties
- Best cost in use ratio
- High recyclability in thermoplastics
- Cleanliness
- Flame retardancy (synergy in combination with other flame retardants)
- Thermal dissipation
- UV resistance
- Black tinting

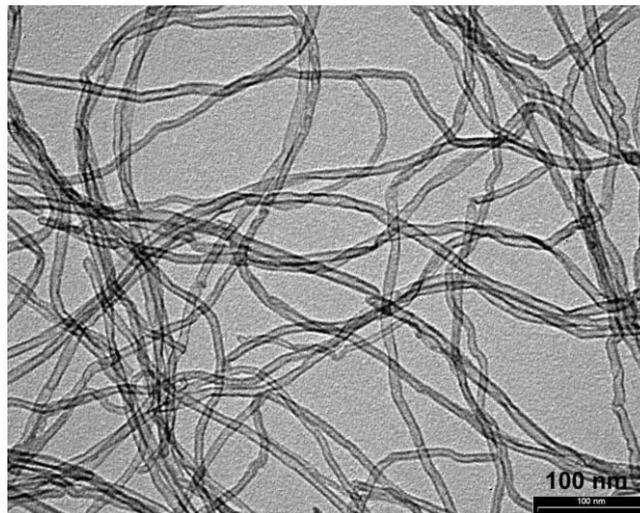
## Technical Data

### Main Characteristics

NANOCYL® NC7000™ series (Figure 1), thin multi-wall carbon nanotubes, are produced via the Catalytic Chemical Vapor Deposition (CCVD) process.

NC7000™ carbon nanotubes are tube-shaped materials, exclusively composed of carbon atoms, having a nanometric diameter. The graphite layer can be visualized somewhat like a rolled-up chicken wire with a continuous unbroken hexagonal mesh and carbon atoms at the apexes of the hexagons. With action of van der Waals forces, NC7000™ carbon nanotubes have a tendency to cluster into bundles or agglomerates. Consequently, NC7000™ carbon nanotubes look like a black powder. At nanoscale, they have a spaghetti-like structure.

Figure 1. NC7000™ multiwall carbon nanotubes – scale: 100 nm - TEM.



### Specific characterization of NC7000™

PROPERTIES	UNIT	VALUE	METHOD OF MEASUREMENT
Average diameter	$10^{-9}$ m	9.5	Transmission Electron Microscopy (TEM)
Average length	$\mu$ m	1.5	Transmission Electron Microscopy (TEM)
Carbon purity	%	90	Thermogravimetric analysis (TGA)
Transition Metal oxide	%	< 1%	Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
Amorphous carbon	-	*	High resolution Transmission Electron Microscopy (HRTEM)
Surface Area	$\text{m}^2/\text{g}$	250-300	BET surface area analysis
Volume resistivity	$\Omega.\text{cm}$	$10^{-4}$	Internal test method (resistivity on powder)

\*Pyrolytically deposited carbon on the surface of the NC7000

## Electrical percolation curves for volume and surface resistivity

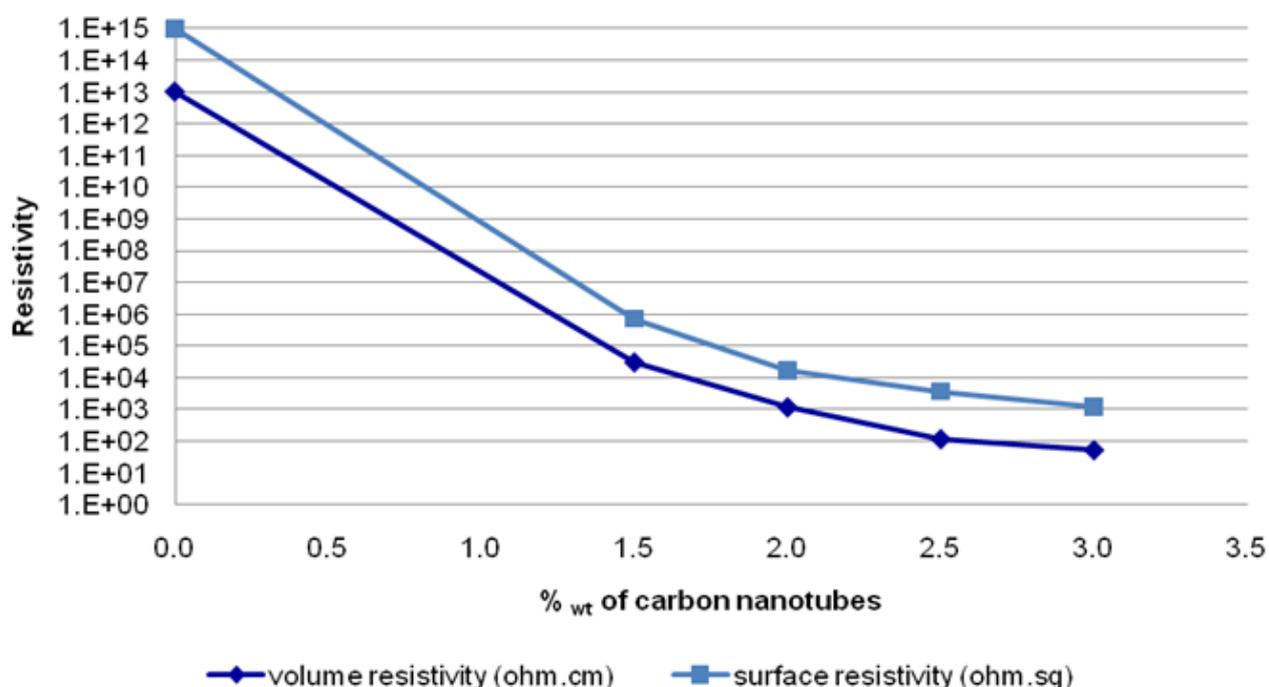
In thermoplastics, NC7000™ carbon nanotubes bring electrical conductivity with a low percolation threshold between 0.5 wt.% and 4.5 wt.%.

**IMPORTANT NOTE:** The loading of NC7000™ to achieve a targeted electrical conductivity depends on the dispersion process, the type of polymer (PC, PA, PP, HDPE, etc.) and also of the grade of polymer (viscosity, molecular weight, and so on.)

In general, CNTs are more easily dispersed in polar thermoplastics.

For example, surface resistivity reaches  $10^6$  [ohm.sq] with a 1.5 wt.% of NC7000™ in a specific polycarbonate (Figure 2).

**Figure 2. Electrical percolation curve EXAMPLE: polycarbonate (PC) – NC7000™ concentrate.** Electrical resistivity measurement in accordance with Nanocyl standard method based on standard injection molded IZOD specimens.



The main advantage of NC7000™ is that they affect less the mechanical properties (e.g. elongation at break) than other conductive fillers such as carbon blacks (CB) or graphite. This is due to the high aspect ratio of NC7000™ resulting in a very low amount of NC7000™ needed to reach a specific conductivity.

NC7000™ increase more the viscosity than CB at equal loading, but the much lower quantities of NC7000™ required render the processing better in most cases or comparable. NC7000™ concentration below 1 wt.% in thermoplastics improves elongation at break and impact resistance without affecting tensile strength and keeping the thermoplastics electrically insulating. NC7000™ in thermoplastics offer additional improvement in cleanliness, thermal dissipation, recyclability, flame retardancy, black tinting and UV resistance.

## Commercial/Safety Information

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### Packaging

NC7000™ carbon nanotubes are available in powder form and are provided in industrial standard 2.5 kg cardboard.

Standard pallet maximum quantity is 90 kg. Standard 40" container maximum quantity is 1800 kg.

Pre-dispersed forms are also available in various matrices:

- Thermoplastics: PLASTICYL™,
- Epoxy resin: EPOCYL™
- Water dispersion: AQUACYL™
- Elastomers: ELASTOCYL™
- NMP: ORGACYL™.

### Minimum Order of Quantity

Nanocyl's minimum order of quantity for NC7000™ is 2.5 kg.

**IMPORTANT NOTE:** For first technical developments and ease of use in laboratory, 500 g of NC7000™ in a bottle with double caps can be ordered. A fixed price is applied due to additional re-packaging costs of those small quantities (close to the price for 2.5 kg of NC7000™).

### Health and Safety

A Material Safety Data Sheets (MSDS) is available to provide both workers and emergency personnel with the proper procedures for handling or working with the NC7000™. This MSDS includes information such as physical data (form and color, melting point, etc.), handling and storage recommendations, first aid measures and ecological information. The Safety Data Sheet is provided with any order and should be observed.

## Disclaimer

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