

	Safe Handling Guide GRAPHISTRENGTH® Multi-Walled Carbon Nanotubes	
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This document is a guide to safe handling of GRAPHISTRENGTH® multi-walled carbon nanotubes. This document is provided as a supplement to the Material Safety Data Sheet (MSDS).

ALL PERSONS USING GRAPHISTRENGTH® MULTI-WALLED CARBON NANOTUBES MUST READ AND UNDERSTAND THIS GUIDE AND THE MSDS BEFORE HANDLING.

GRAPHISTRENGTH® Carbon Nanotube Products

GRAPHISTRENGTH® products comprise multi-walled carbon nanotubes. Typical GRAPHISTRENGTH® multi-walled carbon nanotube diameter is 10 to 15 nanometers; typical length is approximately 1 to 10 microns. GRAPHISTRENGTH® multi-walled carbon nanotubes exist in agglomerated bundles with average dimensions of about 400 microns, with a range of approximately 50 to 900 microns.

Using GRAPHISTRENGTH® multi-walled carbon nanotubes may pose a risk of exposure. This guide identifies good practices for handling GRAPHISTRENGTH® multi-walled carbon nanotubes to minimize worker exposure and environmental release.

Safe Handling

BEFORE HANDLING, READ AND UNDERSTAND THE MSDS (MATERIAL SAFETY DATA SHEET), WHICH PROVIDES ADDITIONAL INFORMATION ON PERSONAL PROTECTIVE EQUIPMENT AND SAFETY, HEALTH AND ENVIRONMENTAL MATTERS.

The toxicological properties of GRAPHISTRENGTH® multi-walled carbon nanotubes are not completely understood and are the subject of ongoing studies. The goal in safely handling GRAPHISTRENGTH® multi-walled nanotubes is to eliminate, to the extent possible, contact with people and the environment, via any exposure route.

Access to work areas where GRAPHISTRENGTH® multi-walled carbon nanotubes are present should be restricted – to limit the number of workers potentially exposed. For workers in the restricted areas, the best way to avoid exposure is to use GRAPHISTRENGTH® multi-walled

carbon nanotubes with engineering controls that fully protect workers from exposure, i.e. in closed, negative pressure processes equipped with high efficiency particulate air (HEPA) filtration.

Whenever workers are reasonably likely to be exposed to GRAPHISTRENGTH® multi-walled carbon nanotubes, dermally or by inhalation, appropriate personal protective equipment (PPE) as described below is required. In these cases, local exhaust ventilation equipped with HEPA filtration still should be used to the extent possible to minimize reliance on PPE.

To minimize risks associated with the introduction of GRAPHISTRENGTH® multi-walled nanotubes to processing equipment, ARKEMA has developed a proprietary system that can be used in certain applications, including compounding of thermoplastics. ARKEMA can propose this proprietary feeding system to its customers to further control exposure in their facilities. More information is available on request.

Engineering controls: Investigate opportunities to use engineering controls, including local exhaust systems, lab hoods or enclosed systems to reduce exposure. Any ventilation system must be equipped with HEPA filtration.

Required PPE when handling GRAPHISTRENGTH® Carbon Nanotube Products:
Where inhalation could occur: Workers who are reasonably likely to be exposed by inhalation in the work area to Arkema multi-walled carbon nanotubes are required to wear one of the following respirators:

- a. NIOSH-certified* air-purifying, tight-fitting full-face respirator equipped with N-100, P-100 or R-100 filter; or
- b. NIOSH-certified* powered air-purifying respirator with a loose-fitting hood or helmet and a HEPA filter with documented evidence of an APF of 1,000; or
- c. NIOSH-certified* continuous flow supplied air-purifying respirator with a loose-fitting hood or helmet and a HEPA filter with documented evidence of an APF of 1,000.

*Or equivalent certification for Europe.

While any of the respirator options above is acceptable, Arkema encourages users to consider hood type air supplied respirators or hood type powered air purifying respirators equipped with HEPA (H14 in Europe) filtration. Use of these types of respirators provides several benefits including: 1) higher assurance of consistent worker protection factors, 2) increased worker comfort, 3) elimination of fit testing requirements, 4) improved protection, 5) ease of identifying potential contamination through product color contrast with hoods and, 6) equivalent or, in some cases reduced cost, with respect to full face negative pressure respirator use.

For any exposed body part: For tasks with exposure potential, including dermal exposure in the work area through direct handling of GRAPHISTRENGTH® multi-walled carbon nanotubes or through contact with equipment on which GRAPHISTRENGTH® carbon nanotubes multi-walled may exist, workers are required to wear personal protective equipment (PPE) including full body impervious chemical

protective clothing and impervious gloves. Each such item of personal protective equipment must be selected and used in accordance with OSHA dermal protective requirements 29 CFR 1910.132, 1910.133 and 1910.138. Protective garments / gloves must demonstrate performance according to ASTM F1671 or NFPA 1999 in the US, or in Europe, ISO 16604 (protective clothing) and EN 374-2 (gloves). Gloves may not be used for a time period longer than they are actually tested and must be replaced at the end of each work shift.

Any cleaning operations including routine housekeeping or spill response must be performed using methods that will prevent powder dispersion. Use of a HEPA filtered vacuum cleaner (H14 efficiency in Europe) for cleaning is required. This can be supplemented by surface wiping with a damp cloth.

After coming in contact with multi-walled carbon nanotubes, all materials, including cleaning cloths, gloves, respirator cartridges, non-reusable PPE, PPE cleaning materials, etc., must be disposed of in a licensed hazardous waste incinerator.

Process monitoring should be performed to assure effectiveness of the control systems in place. This includes:

- Performance verification testing of engineering controls.
- Visual inspections of PPE and work area conditions.
- A review of viable options for air monitoring that will detect the presence of GRAPHISTRENGTH® carbon nanotube products, or more generally that will allow comparison of particle counts or particle size ranges during processing to established background levels.

GRAPHISTRENGTH® multi-walled carbon nanotubes may form combustible dust-air mixtures. Combustible dusts are fine particles that may present an explosion hazard when suspended in air under certain conditions. Dust explosion characteristics vary with particle size, particle shape, moisture content, contaminants, and other variables.

Packaging

To minimize exposure risk during transport and storage, ARKEMA supplies GRAPHISTRENGTH® products in appropriate, re-sealable containers. After use, when these containers are empty, ARKEMA recommends cleaning with a HEPA vacuum cleaner (H14 efficiency in Europe). During this operation, the recommended PPE described above must be used.

Waste Disposal

1. Incinerate all wastes that may be contaminated with GRAPHISTRENGTH® multi-walled carbon nanotubes including used PPE, PPE cleaning materials, filters from respirators, vacuum cleaners and exhaust systems, and any spill clean up or product containing clean-out wastes
2. Do not water wash empty containers, spill areas or equipment – use HEPA (H14) filtered vacuum, damp / tacky cloth wash to the maximum extent possible to remove residues. Empty containers may undergo incineration. Properly cleaned empty metal containers may be offered for recycling
3. Any wastewater that is generated must be incinerated in a licensed hazardous waste incinerator.
4. Do not reuse empty Arkema product containers for other purposes.

First Aid

- Immediately flush eye(s) with plenty of water. Get medical attention if irritation persists.
- In case of contact, immediately flush skin with plenty of water. Incinerate contaminated clothing and shoes. Get medical attention if irritation persists. Wash clothing before reuse. Thoroughly clean shoes before reuse.
- If swallowed, DO NOT induce vomiting. Get medical attention. Never give anything by mouth to an unconscious person.
- If inhaled, remove victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

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