

Standard Operating Procedure

Carbon Fiber Fabrication and Handling

Laboratory Safety Manual

Department:	Mechanical Engineering
Date SOP was written:	11/4/2015
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Location(s) covered by this SOP:	Olin 413, Olin 515

Type of SOP: ☒ Process ☐ Hazardous Chemical ☐ Hazardous Class

Purpose

Carbon Fiber Composites are used widely in the Vanderbilt Aerospace Design Laboratory due to their high specific strength and formability. The carbon exposure hazard includes fly, dust, fiber (cured/uncured), and matrix vapor/thermal decomposition products. By using the recommendations in this document, a high level of confidence can be assured for the protection of personnel and equipment.

Physical & Chemical Properties/Definition of Chemical Group

PHYSICAL STATE: Solid

Odor: Odorless

Materials- Graphite fiber tows and epoxy resin

Potential Hazards/Toxicity

The principal hazard in handling carbon fibers is the risk of direct physical contact by personnel. The two major routes to employee exposure from reinforced fiber materials are dermal and inhalation. The disrupted carbon fiber is easily airborne and widely distributed. Carbon fiber exposure can cause mechanical irritation and abrasion similar to that of glass fibers (OSHA 1999). Skin rashes often occur and are reportedly more severe than from glass fibers. Commonly used carbon fibers are greater than 5 μm in diameter, making them small enough to be inhaled, but large enough to allow lung tissue to encapsulate the fibers and expel them from the body. Carbon fibers are very fine and easily broken by stretching (by less than two percent elongation), and can become a fine dust or fly during any handling operations. This includes manufacturing, qualification, processing, test and evaluation, service, and disposal. If uncontrolled, these composite structures and associated microfibers have the potential to stick to human skin or mucous membranes and cause irritation, particularly to eyes, skin, and lungs. This is compounded when high energetic events are coupled with fire during service or destructive evaluation. Additionally, in the service environment, elements of dispersion are much harder to control and thus contain the carbon hazard.

Personal Protective Equipment (PPE)

- **RESPIRATORY PROTECTION:** Self Contained Breathing Apparatus or negative air pressure respirator with HEPA filters in any dust producing operation
- **VENTILATION:** Active air flow for all cutting operations
- **HAND PROTECTION:** many gloves are applicable depending on the application. See chart below.

Glove Types and Hazard Protection

Glove Type	Protects Against
Cotton	Abrasions
Disposable Plastic (Latex)	Microorganisms, mild irritant, fibers
Natural Rubber (Latex)	Acetone (<1hr), epoxies, Methyl ethyl ketone (MEK)
Leather, Aramid	Abrasions, punctures, and fibers
Neoprene	Acetone (>1hr), epoxies, N-methylpyrrolidone (NMP)
Nitrile	Epoxies, isocyanates
Polyvinyl alcohol	Methylene chloride, toluene, Methyl isobutyl ketone (MIBK), styrene, Tetrahydrofuran (THF)
Polyvinyl chloride	Dimethylsulfoxide (DMSO), isopropyl alcohol, epoxies
Butyl rubber	Dimethylformamide (DMF)
Viton	Methylene chloride, 1,1,1-trichloroethane, toluene

SHARP 1998. A Guide to Preventing Dermatitis while Working with Advanced Composite Materials Publication 55-03-1999

- **EYE PROTECTION:** Safety Glasses
- **OTHER PROTECTIVE EQUIPMENT:** Covered clothes over whole body and close toed shoes

First Aid Procedures

By using the appropriate hazard controls, prevention is the best approach to avoid exposure to carbon fibers and composites; however, if exposed, personnel need to react immediately. In all cases of exposure, personnel must be removed from the contaminated environment to apply first aid. Removal must be accomplished in a manner that does not contaminate attending and/or non-protected personnel. Flushing with large amounts of water is recommended, so safety showers and eye wash stations must be accessible. This might require mobile/portable units or other acceptable deluge facilities to be placed in near proximity. The American National Standards Institute (ANSI) offers guidance on emergency showers and eyewashes (ANSI Z358.1). Advanced medical treatment should be administered after initial first aid techniques have been applied. Personnel who have been exposed to carbon fibers should continue to monitor and document at a regular interval any noticeable effects and set up a follow-up medical appointment for continued care.

Medical personnel must always be notified in case of an exposure. The Japan Carbon Manufacturers Association suggests that for skin exposure, the affected area should be rinsed and flushed with soap and water. If fibers and irritation persist, sticky tape, or even fixing-type glue, can be used to grab and remove the fibers (SHARP 1998). Larger fibers can be removed by hand or with tweezers. If irritation persists, professional medical attention must be sought. Although carbon fiber is difficult to image, X-ray radiography may be performed in addition to pulmonary studies.

If skin or eye exposure occurs, flushing with water should be performed for a minimum of 15 min in an ANSI Z358.1-compliant emergency shower or eyewash, if available, or any other flushing facility if not available, using potable water or other suitable flushing fluid. If contact lenses remain in the eye after flushing, the lenses may require medical help to remove. The contact must be removed from the eye prior to further flushing and rinsing behind the eyelid. It was believed that contact lenses can absorb irritants and cause further damage, including cornea damage, during flushing, but the American Chemical Society Committee on Chemical Safety and National Institute for Occupational Safety and Health (NIOSH) have debunked this as unproven. However, contact lenses, like food, beverages, items of a personal nature, clothing, PPE, etc., should not be reused if exposed to carbon dust or fly. The exposed eye must be flushed for a minimum of 15 min while medical personnel are notified. Contaminated clothing should be removed while flushing the skin. Once exposed personnel are in the care of emergency medical personnel, the medic will determine if additional flushing, first aid, and/or further medical treatment is required. Exposed items should be decontaminated if possible and if this is unachievable, should be disposed. In case of inhalation, the victim is typically moved to fresh air and medical personnel are consulted.

In the unlikely event that ingestion occurs, skin exposure first aid is applied, followed by dilution by drinking 2 to 3 glasses of water; however, this is a medical issue and medical authorities will make the appropriate determination of treatments.

Spill and Accident Procedure

- Assess the situation, considering ventilation to control dust.
- If physical injury has occurred, visit the hospital or call 911
- If fire has occurred, extinguish and consider risk of evaporating resin toxicity

Medical Emergency Dial **911**

Decontamination/Waste Disposal Procedure

Structures constructed of carbon fiber are for the most part inert and stable once cured, contained, or fixed. The composite is considered fixed when the potential exposure to dust or fly no longer exists. Double bagging, wrapping or taping sharp or exposed edges, and encapsulation are appropriate ways to fix a disrupted composite structure. Carbon fiber that has experienced a combustion and/or highly energetic event is tenacious and much more difficult to control and contain. The severity and method of disposal is largely a function of the amount of material that requires disposal; however, even though uncontaminated carbon fiber is not U.S. Environmental Protection Agency regulated hazardous waste, it is still subject to local landfill disposal requirements.

Regardless of the destruction method, personnel and equipment need to be protected from dust, fiber, or fly exposure. Personnel should double bag the composite material while using the appropriate hazard controls. Identification labels should be placed between the double bags to document the type of waste inside. Carbon fiber wastes should be regarded and labeled as "Industrial Wastes".

Workspace must be cleaned after cutting with shop vacuum

Procedure/Use	Scale	Engineering Controls/Equipment	PPE (eye, face, gloves, clothes)	Procedure Steps and Precautions
1. General Cutting (dust producing applications)	N/A	Make cuts on 1/16"-1/8" Thick Carbon Fiber with an abrasive wheel Do not work alone Ensure above adequate ventilation with active airflow Shop vac for dust collection	Eye protection: Safety Glasses Gloves: Nitrile gloves Clothing: Close toes shoes and no exposed skin Respiratory: Self contained breathing apparatus or dust mask	1. Ensure PPE and ventilation 2. Prepare shop vacuum and buddy check your working partner for PPE and readiness AVOID SKIN CONTACT AND BREATHING WITH CARBON FIBER DUST 3. Perform Handling operations 4. Clean Workspace with Rag and shop vac

Documentation of Training (signature of all users is required)

- Prior to conducting any work with polyester resin, designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.
- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Identification	Date
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