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# Unreasonable Risk

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## INTRODUCTION

As in any profession, employees in any O/P laboratory are at a constant risk to injury in one way or another every day. Be it slipping on a wet floor or cutting a finger with a knife, these risks are accepted because they are remote, and the cause and effect of the risks are obvious.

Unreasonable risk is yet another matter. Unreasonable risk without knowing it can lead to possible and probable injury. Therefore, it is important to recognize and understand the potential risks to which the O/P profession is exposed and to learn to avoid them through safe practices and work habits.

This presentation is not an editorial or opinion of the author, it is an accumulation of government† occupational health and safety documentation and safety data sheets from specific manufacturers. Whenever possible, direct quotes are used from the documents listed in the references.

An important factor to consider is that all the materials and chemicals reviewed present virtually no health risks if handled properly. This guideline is intended as a source of information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

†Geneva, Switzerland, International Labor Office. Washington, D.C., NIOSH/OSHA Office.
Hamilton, Canada, Canadian Center for Occupational Health & Safety.

## FIBERGLASS

Fiberglass is available in many forms. The composition and physical properties depend upon the application. For reinforcing plastics, the fibers are usually 6 to 9 micrometers in diameter. A common binder used in fiberglass weaving techniques is phenal-formaldehyde. Fiberglass is flexible, resistant to heat and chemicals, and not soluble in any solvent.

### Health Hazards

***Skin*** "Fiberglass dust and filaments can cause considerable skin irritation characterized by itching, redness and swelling. The larger, more rigid, the fiber, the greater the irritation. There is apparently no allergic reaction to fiberglass. Adverse dermatitis effects are reversible if exposure ceases."[1]

***Lungs*** "Inhalation of fibrous glass dust does not appear to have caused major health problems in workers. Long exposure to dust *did not* cause harmful effects as measured by x-ray examination of lungs, tests of lung function, mortality (death rates) or cancer incidence."[1]

"In some studies, workers had excessive rate of chronic bronchitis and emphysema. The adverse health effects were said to be non-disabling and reversible if exposure ceased."[1] Inhalation of fibrous glass dust by experimental animals did not cause fibrosis (growth of scar tissue in the lungs) or cancer.[1] Fibrosis is not regarded as a human hazard of these fibers.[2]

*Eyes* Loose airborne filaments may cause a potential hazard and subsequent eye injury. "Needle sharp fragments of unattended fiber may cause penetration and eye injury hazard so eye protection is necessary."[2]

*Cancer* "There is considerable evidence that *inhalation* of fibrous glass dust does not cause cancer in workers or experimental animals."[1]

*Protective Equipment*

- Eye Glasses
- Particle Dust Mask
- Clean Lab Coat
- Latex Gloves

*Storage and Handling* Use a well ventilated room with good lighting. It is recommended to cover fibrous glass with plastic to prevent filaments from becoming air borne.[2]

*First Aid and Emergency Procedures* Upon development of a rash or skin irritation, discontinue handling of fiberglass and seek medical attention. In event of a loose filament entering the eye, do not attempt to wash away. Seek immediate medical attention.[2]

*Fire Fighting* Fiberglass is a non-combustible and does not pose a fire hazard.[2]

## CARBON (GRAPHITE)

Carbon is derived from two sources: natural and synthetic. Whereas natural carbon can cause the disabling lung disease "pneumoconiosis," synthetic carbon, a petroleum product, is considerably safer. Synthetic graphite is the choice used in the orthopaedic industry.

### Health Hazards

*Skin* Dust and filaments may cause minor skin irritation. The adverse conditions are reversible if exposure ceases.[3]

*Lungs* Synthetic carbon produces minor irritation of the respiratory tract, but no lasting tissue damage.[3]

*Eyes* Loose airborne filaments may cause a potential health hazard and subsequent eye injury.[3]

*Cancer* No data was obtained discussing the relation of cancer and synthetic graphite.

*Protective Equipment*

- Eye Glasses
- Particle Dusk Mask
- Latex Gloves
- Clean Lab Coat

*Storage and Handling* Use a well ventilated room with good lighting. It is recommended to cover carbon fabrics with plastic to prevent airborne filaments.[3]

*First Aid and Emergency Procedures* Upon development of a rash or skin irritation, discontinue handling of synthetic graphite and seek medical attention. In the event of loose filaments entering the eye, do not attempt to remove. Seek immediate medical attention.[3]

*Fire Fighting* Carbon poses no significant fire or explosion hazard unless airborne concentrations are extremely high.[3]

## KEVLAR®

Kevlar® is a Du Pont trade name for a class of aromatic polyamide fibers.

### Health Hazards

*Skin* "In human patch tests, no skin irritation was observed after 48 hours of continuous contact."[4]

*Lungs* "Based on animal insufflation tests, respirable dust from Kevlar® produces what would be considered a typical lung reaction to a nuisance dust particulate."[4]

*Eyes* Loose airborne filaments may cause a potential health hazard and subsequent eye injury.[4]

*Cancer* No material was obtained by the author discussing the relationship of Kevlar® and cancer.

*Protective Equipment*

- Eye Glasses
- Particle Dust Mask
- Latex Gloves
- Clean Lab Coat

*Storage and Handling* Use in a well ventilated and well lit room. Kevlar® should be stored under a plastic cover to discourage any airborne filaments.[5]

*First Aid and Emergency Procedures* In the event of airborne filaments entering the eye, do not attempt to wash away; seek immediate medical attention.[4]

*Fire Fighting* Kevlar® is a fire retardant and does not support combustion.[5]

# ACRYLIC (Methyl-Methacrylate) ($CH_2$ $OCH_3$ $COOCH_3$)

Acrylics encompass a large variety of resins and plastics that are slightly soluble in water, very soluble in organic solvents, and classed as a colorless liquid with a fruity smell. Although there are many blends and brands of acrylic resins and plastics, they are all based as a methyl-methacrylate and can be treated equally with concern to health and safety.

## Health Hazards

*Skin* Methyl-methacrylate is allergenic and can cause dermatitis on prolonged exposure to the skin.[6]

*Lungs* Overexposure to methyl-methacrylate may cause irritation to the nose, throat, skin, and eyes. It is considered a narcotic and may also cause drowsiness and at very high levels, unconsciousness.[7]

*Eyes* Extreme care should be taken to ensure no contact is made with liquid acrylic and the eyes. Dust generated from polymerized acrylic should be avoided.[6]

*Cancer* "No data are thus far available for the evaluation of carcinogenic power to humans of acrylic resins."[6]

*Protective Equipment*

- Eye Glasses
- Latex Gloves
- Lab Jacket (long sleeve)
- Dust Mask

*Storage and Handling* Liquids should be stored in a no smoking room at room temperature and not exposed to sunlight. A well ventilated room should be maintained.[7]

"Since its (acrylic) odor threshold is below the permissible exposure limit, and since irritation occurs within three times the permissible exposure limit, methyl-methacrylate is treated as a material with good warning properties."[7]

In the event of a spill of excessive amounts of acrylic, "Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed."

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. "For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood duct work. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable location away from a combustible chamber. Methyl-methacrylate should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion."[7]

## First Aid and Emergency Procedures

*Eye Exposure* "Wash eyes immediately with large amounts of water, lifting the

lower and upper lids occasionally. Get medical attention as soon as possible."[7]

*Skin Exposure* "Promptly flush the contaminated skin with water. If clothing is soaked, remove immediately and flush the skin with water. Clothing should not be re-worn until all the acrylic is removed. If there is any skin irritation, seek immediate medical attention."[7]

*Overexposure* If large amounts are inhaled, remove the person to fresh air at once.[7]

*Swallowing* In the unlikely event of swallowing liquid acrylic, get medical attention immediately. If it is not available, get the afflicted person to vomit. Do not induce vomiting to an unconscious person.[7]

*Fire Fighting* "Methyl-methacrylate will ignite at 421°C (790°F). It can be extinguished with dry chemical foam or carbon dioxide. During decomposition toxic gases and vapors (such as carbon monoxide) may be released."[7]

# POLYESTER

There are many different types, brands, qualities, and materials referred to as polyester (e.g., resin, tape, Mylor, Dacron, Acylid paint).

For use in orthopaedics, the material technically is polyester resin in styrene solution. Styrene is a reactive monomer, clear and colorless, oily liquid. It has a sharp sweet odor and is a necessary consideration when evaluating the hazards and safety of polyeser resin as used in laminating.

## Health Hazards

*Skin* Contact with the skin can cause dermatitis and dissolve skin oils.[13]

*Lungs* "Brief exposure to high concentrations of styrene vapor can cause irritation of the nose, throat, and lungs. Prolonged exposure to high concentrations of vapor (10,000 ppm for ½ hour or 2,500 ppm for 8 hours) can cause paralysis of the central nervous system and result in unconsciousness and death. Lower concentrations of vapor can cause mild to moderate irritation."[12]

"The most common health effects of mixing, shaping, and curing styrene-modified polyester resins relate to carcosis (headache, dizziness, drowsiness, anorexia, vomiting) and mucosal irritation (burning of eyes, sneezing, coughing) from styrene vapor and to the dermatitis potential of the components. Odor and irritation help to discourage extended exposure."[11]

*Eyes* Liquids and vapors are irritating to the eyes and contact and exposure should be avoided.[13]

*Cancer* "Styrene produced lung tumors in mice following oral administration. Death from leukemia and lymphoma (cancers of the white blood cells) have been reported in workers exposed to mixtures of styrene, benzene, and butadiene. The cancers cannot be attributed to styrene alone. As well, there is evidence that styrene has caused chromosome aberrations and other genetic damage in workers: Genetic damage may indicate an increased risk of cancer. These results are cause for concern that styrene may increase the risk of cancer in humans."[12]

*Reproductive Effects* "There is one report of an increased incidence of birth defects among women working in plastic boat factories. The women were exposed to styrene, polyester resins, organic peroxides, and solvents."[12]

*Protective Equipment*[13]

- Eye Glasses
- Clean Lab Coats (long sleeve)
- Latex Gloves

*Storage and Handling* Polyester resin and styrene solutions should be stored in a dry, cool place away from strong oxidizing agents. Good housekeeping should be

maintained in a no smoking room with good ventilation.[13]

### First Aid and Emergency Procedures

*Eye Contact* Flush eyes immediately with water; seek immediate medical attention.[13]

*Skin Contact* Clean skin with nonirritating agents such as waterless hand cleaners or an equal mixture of acetone and sulphonated oil cleaner. Never use req solvents to clean the skin. If a rash develops, seek medical counsel.[13]

*Fire Fighting* Polyester resin in styrene solution will burn if heated strongly or exposed to flame or sparks. It emits acrid, toxic fumes when burning or decomposing.[12]

## DIMETHYLANILINE ($C_6 H_5 N(CH_3)_2$

This is a straw to brown colored liquid with a characteristic ammonia-like odor used to promote the curing of thermosetting polyester resin.

### Health Hazards

*Skin* Dimethylaniline affects the body by contact with the skin. "Overexposure to Dimethylaniline may affect the ability of the blood to carry oxygen. Dimethylaniline has been shown to cause methemoglobinemia."[14]

*Lungs* "Dimethylaniline absorption, whether from inhalation of the vapor or by skin absorption of the liquid, causes anoxia due to the formation of methemoglobin. It is said to be less toxic than aniline as regards to methemoglobin formation, but more of a central nervous system depressant."[14]

*Eyes* Avoid eye contact with liquid.[14]

*Cancer* No data was obtained discussing the relationship of Dimethylaniline and cancer.

*Protective Equipment*

- Eye Glasses (splash proof)
- Latex Gloves
- Clean Lab Coat (long sleeve)

*Storage and Handling* Store in a cool well ventilated area away from sparks and heat. Ensure containers are well sealed and contamination is not possible. Store Dimethylaniline in its original container.[14]

### First Aid and Emergency Procedures

*Eye Exposure* Wash eyes immediately with large amounts of water; seek immediate medical attention.[14]

*Skin Exposure* Wash contaminated skin immediately with soap or mild detergent. If soaked into clothing, remove and do not re-wear until properly laundered. If rash or irritation occurs, seek medical attention.[14]

*Breathing* In event of overexposure to fumes, expose the person to fresh air and seek medical attention.[14]

*Swallowing* In this unlikely event, have the person drink large amounts of water, then try to make the person vomit. Do not make an unconscious person vomit. Seek medical attention.[14]

*Fire Fighting* Ignition temperature is 371°C (700°F).[14]

Contact with strong oxidizers (Benzoyl peroxide) may cause explosion or fire. Contact with strong acids may cause violent splattering. During decomposition, hazardous products of toxic gases and vapors may be released. Extinguish any fire with foam, dry chemical or carbon dioxide.[14]

## BENZOYL PEROXIDE ($C_6 H_5 (CO_2)_2$)

Benzoyl peroxide is used as a paste to catalyze thermosetting polyester resins and as a powder to cure acrylic resins. The major hazards are fire and explosion; health hazards are uncommon but not negligible.

## Health Hazards

*Skin* Benzoyl peroxide is used in medicine for treatment of acne. It may cause dermatitis and skin irritation to more sensitive skin.[9]

*Lungs* Fumes may cause nose and throat irritation.[9]

*Eyes* Avoid any contact of Benzoyl peroxide or fumes with the eyes.[8]

*Cancer* "(Benzoyl Peroxide) when repeatedly applied to the skin of mice, was not a carcinogenic."[8]

*Protective Equipment*

- Eye Glasses
- Latex Gloves
- Clean Lab Coat (long sleeve)

*Storage and Handling* Benzoyl peroxide should be stored in its original containers in a cool, ventilated place apart from other flammable or reactive materials. It should be protected from flame, static electricity sparks or sources of heat such as steam pipes, radiators, or direct sunlight. Care must be taken not to contaminate Benzoyl peroxide. Empty Benzoyl peroxide containers should be destroyed. Keep the lid tightly on the container at all times.[8]

## First Aid and Emergency Procedures

*Eye Exposure* Wash eyes immediately with large amounts of water. If irritation persists after washing, seek medical attention.[8]

*Skin Exposure* Wash contaminated skin immediately using soap or mild detergent. If irritation persists after washing, seek medical attention.[9]

*Swallowing* In this unlikely event, have the person drink large amounts of water, then try to get the person to vomit. If the afflicted person is unconscious, seek immediate medical attention.[8]

*Fire Fighting* Benzoyl peroxide ignites at 103°C (217°F). "It is a powerful oxidizer and contact with wood, paper, and other combustible substances may cause fire."[9]

Hazardous decomposition products of toxic gases and vapors may be released in a fire involving Benzoyl peroxide. "In case of a fire where amounts of Benzoyl peroxide are stored, water should be applied by sprinkler system or by a hose at a safe distance, preferably with a fog nozzle. Portable extinguishers should not be used."[8]

# POLYURETHANE (TWO PARTS: A & B)

Polyurethane foams are a wide class of industrial chemicals in many forms and qualities. Polyurethane foams are formed by the reaction of polyals and isocyanates. Isocyanates are a family of highly reactive chemicals and are the key ingredient and backbone to polyurethane foam. The most common isocyanate is TD1; others in wide use are MD1 and PAP1.

When determining the safety and health hazards of polyurethane foams, an evaluation of isocyanates is imperative. This data refers to flexible foams in liquid, solid or cured states.

## Health Hazards

*Skin* Polyurethane chemicals can cause dermatitis. Avoid contact with skin at all times. Polyurethane dust is very irritating to the eyes. Avoid contact at all times. Isocyanate vapor, liquid and dust will react with the moisture of your skin and dry out the cutamion tissue.[18]

*Lungs* The greatest potential risk to you when you use polyurethane chemicals comes from breathing fumes, mist, or dust. You must avoid breathing these chemicals.

*Eyes* Isocyanate vapor, liquid, or dust will react with the moisture of your eyes.[15]

*Cancer* "In 1978, Thyssen et al., of Germany published the paper, 'Inhalation Studies with Polyurethane Foam Dust in

Relation to Respiratory Tract Carcinogenesis.' Male and female Sprague-Dawlwy rats were exposed to freshly generated polyurethane foam dust, in concentrations averaging 8.65 mg/m3 air, for 6 hours daily, 5 days a week, over a period of 12 weeks. No indication of a carcinogenic effect of the inhaled dust on the respiratory tract could be established. However, any dust particles that enter the lungs can cause some risk."[15]

*Protective Equipment*

- Eye Glasses
- Clean Lab Jacket (long sleeve)
- Latex Gloves
- Respirator or Well Ventilated Room

***Storage and Handling*** Store indoors in a well ventilated no smoking room away from heat sources and sunlight. Containers should be kept well sealed, because the chemicals react adversely to water and moisture in the air to produce carbon dioxide gas. If trapped in a closed container, the gas can build pressure to explode or spray chemicals upon opening. If a polyurethane container is bulging, wear proper safety equipment and slowly unscrew the cap to allow the gases to escape. Cured foams are to be handled with equal care. Dust particles should not be exposed to skin, eyes or lungs, and dust should not be allowed to accumulate in any quantity. Cured foam should only be used in non-smoking areas.[19]

## First Aid and Emergency Procedures

***Eye Exposure*** Flush eyes immediately with large amounts of water for 15 minutes; seek immediate medical attention.[19]

***Inhalation*** Leave the area, breathe pure oxygen if possible; seek medical attention immediately.[19]

***Skin Exposure*** Clean contaminated area with clean towels and mild detergent or soap. Then wipe with rubbing alcohol, do not use solvents or acetone. If a rash develops, seek medical attention.[19]

Prevent foam dust from skin contact, body moisture will be absorbed and dry the skin.[19]

***Swallowing*** Isocyanates are not very poisonous, but they will react with the lining of your throat and stomach and can cause damage to these tissues.[16]

In this unlikely event, have the affected person drink large amounts of water and then induce vomiting, repeat vomiting two or three times, seek immediate medical treatment.[19]

***Cured Foam or Dust*** The foam will absorb and react with the mucous membrane in the throat and trachea, and will adversely react with the stomach lining. Never eat or drink in areas where polyurethane dust or vapors are present.[18]

***Fire Fighting*** Polyurethane is extremely flammable in all forms and states. "Flexible polyurethane foams are more hazardous than rigid polyurethane or polyisocyanurate foams. Unlike rigid foams, flexible foams, once ignited, may degrade rapidly and melt to a combustible liquid which may add to the fire involvement. Rigid foam, if ignited, burns dry and in place."[15] Heat, friction and flame will ignite polyurethane. Upon decomposition, a thick smoke containing a *very* toxic gas and vapors is released.[18]

# CONCLUSION

As with most industrial chemicals and materials, perhaps the greatest factor which contributes to potential risk is ignorance or willful disregard of suppliers' recommendations and/or regulatory agencies' requirements. Understand the potential risks—learn to avoid them.[††]

[††] Precautions for the proper usage of polyurethane polyisocyanurates, and related materials (Technical Bulletin 107). 2nd Edition. Kalamazoo, Michigan: The Upjohn Company, 1980.

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