

# PERSONAL PROTECTIVE EQUIPMENT (PPE)



SCME Personal Protective Equipment Learning Module

# Unit Overview

When manufacturing microsystems in a cleanroom environment there are many hazardous materials involved. This unit provides information on the Personal Protective Equipment (PPE) necessary to work with these materials.

- ❖ Why PPE is important in microsystems manufacturing
- ❖ Types of PPE used in microsystems manufacturing
- ❖ How to use the PPE appropriately

# Objectives

- ❖ State why PPE should be used when handling hazardous materials.
- ❖ State the types of PPE commonly used in microsystems manufacturing.
- ❖ Describe the appropriate use of PPE for a specific situation.

# Why Do You Need to Know About PPE?

- ❖ There are many chemical processes involved in the manufacturing of microsystems
- ❖ Large amounts of acids, bases, and solvents are used
- ❖ Chemical use can be dangerous
- ❖ When working with chemicals, PPE must be used

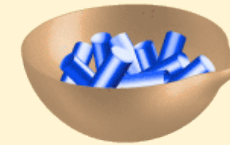


*PPE required for acids, corrosives  
[Picture courtesy of Bob Willis]*

# The Shape of Hazardous Materials

Hazardous materials can be in the following forms:

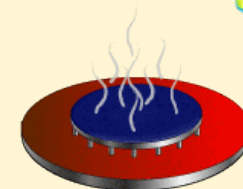
- ❖ Liquids
- ❖ Solids
- ❖ Gases
- ❖ Vapors
- ❖ Fumes
- ❖ Mists
- ❖ Fibers
- ❖ Dust



**Metal Pellets**



**Liquid**



**Fumes**

*Types of Hazardous Materials used in  
Microsystems Fabrication*

**Use the appropriate PPE when working with any hazardous chemical or equipment.**

# Hazards Present in Microsystems Manufacturing

Common hazards in a microsystems manufacturing environment:

- ❖ Health Hazard - Exposure to dangerous chemicals may cause acute or chronic health effects.
- ❖ Physical Hazard - A violent change occurs when subjected to external factors such as heat, vibration, or oxygen, or in some cases, normal temperature and pressure.
- ❖ Equipment Hazard - Exposure to dangerous equipment and/or equipment supplies or tools.

# Specific Hazards

- ❖ What are some chemicals that could be a health hazard?
- ❖ What are some chemicals that create physical hazards?
- ❖ What are some types of equipment hazards?

# Specific Hazards

- ❖ What are some types of chemicals that could be a health hazard?
  - ▣ Carcinogens, corrosives, poisons, irritants, teratogens
- ❖ What are some types of chemicals that create physical hazards?
  - ▣ Flammables, explosives, radioactive, oxidizers
- ❖ What are some types of equipment hazards?
  - ▣ Electrical, mechanical movement, radiation, hot surfaces



# Routes of Entry

Hazardous chemicals may cause bodily damage by one or more of the following routes of entry:

- ❖ Inhalation - breathing it in
- ❖ Dermal (Absorption) - penetrating or irritating the skin or eye
- ❖ Ingestion - swallowing

# Health Hazards

Common health effects caused by exposure to a hazardous chemical.

- ❖ Irritant - irritating effect
- ❖ Sensitizer - allergy developed over time
- ❖ Asphyxiant - suffocation
- ❖ Carcinogen - cancer causing
- ❖ Mutagen - changes genetic makeup
- ❖ Teratogen - affects developing fetus

# Common PPE



PPE includes clothing and other accessories designed to protect against hazards during work and/or play. Here are some examples of PPE:

- ❖ Bullet proof vests
- ❖ Fire protective gear
- ❖ Oven mitts
- ❖ Helmets

PPE makes working and playing safer and more productive.

# Your Turn



What are some common PPE that you use on a regular basis?

# PPE Used in Microsystems Manufacturing

OSHA has PPE Standard

- ❖ PPE OSHA Standard - 29 CFR 1910.132-138
- ❖ Employers must establish and administer proper PPE, a PPE program and PPE training

PPE is available for the following parts of the body:

- ❖ Respiratory system
- ❖ Hands
- ❖ Eyes and face
- ❖ Feet
- ❖ Body

# Atmospheric Hazards

Atmospheric hazards may exist in these forms:

- ❖ Fumes
- ❖ Gases
- ❖ Vapors
- ❖ Particles

## Fumes

- ❖ Contain both gases (vapors) and dusts
- ❖ Require more careful attention than dusts or vapors
- ❖ Need to control the generation of fumes
- ❖ Use fume hoods and other engineering controls

# PPE for the Respiratory System



*Air Purifying Respirator and Supplied Air Respirator  
[Pictures courtesy of MATEC]*

## What is a Respirator?

- ❖ A respirator is used when ventilation controls are not available
- ❖ A respirator is worn over the nose and mouth
- ❖ Two types of respirators which will be discussed:
- ❖ Air Purifying Respirators (left picture)
- ❖ Supplied Air Respirators (right picture)

# How to Use a Respiratory

## Concerns Before Using a Respirator

- ❖ Using a respirator requires the lungs and the heart to work harder
- ❖ If you have heart or lung conditions, a respirator may be dangerous
- ❖ Facial hair prevents the respirator from making a proper seal
- ❖ Shave any facial hair that touches the edge of the respirator

## Properly Fitting a Respirator

- ❖ You must be fit-tested by a qualified person at least once a year
- ❖ A **seal check** must be performed every time a respirator is used



# How to Perform a Seal Check

- ❖ Firmly cover the exhalation ports on the mask with the palms of your hands
- ❖ Inhale and exhale more strongly than usual
- ❖ If no air flows in or out of the respirator's seal is detected, then the respirator fits properly.



# PPE for Hands



*Acid Gloves and Solvent Gloves*

Hand protection is required when handling acids or solvents. It is important to wear "acid gloves" when working with acids and "solvent gloves" when working with solvents.

# Proper Use of Acid and Solvent Gloves

- ❖ Wear over cleanroom disposable gloves
- ❖ Acid gloves - thick rubber based composites (nitrile rubber, butyl rubber, natural rubber)
- ❖ Solvent gloves - commonly made of thick nitrile
- ❖ Make a 2" cuff to prevent chemical from running down the arm
- ❖ When removing, pull from the cuffs, turning the gloves inside out.
- ❖ Place into the respective acid or solvent waste container



**Acid glove with 2" cuff**



**Proper glove removal**

*[Pictures courtesy of Bob Willis]*

# PPE for Hand (Continued)

## Leak Test

Acid gloves and solvent gloves must be checked for holes or leaks

- ❖ Test Method 1: Seal the edges of the glove to your mouth with your hand, blow into it like a balloon. Listen for air leaks.
- ❖ Test Method 2: Inflate with nitrogen and submerge in water. Watch for bubbles.

If a leak is detected, dispose of the glove. Perform the leak test with a new pair of gloves. Repeat this process until no leaks are found.

# PPE for Eyes

## Safety Glasses and Eye Goggles

- ❖ Eye goggles and/or safety glasses are common gowning attire
- ❖ Safety glasses and goggles must have side shields
- ❖ Contact lenses are discouraged when working in a cleanroom; therefore, goggles or safety glasses are generally made to fit over eye glasses
- ❖ Eye goggles and safety glasses can be made with prescription lenses



# PPE for Face

## Face Shield

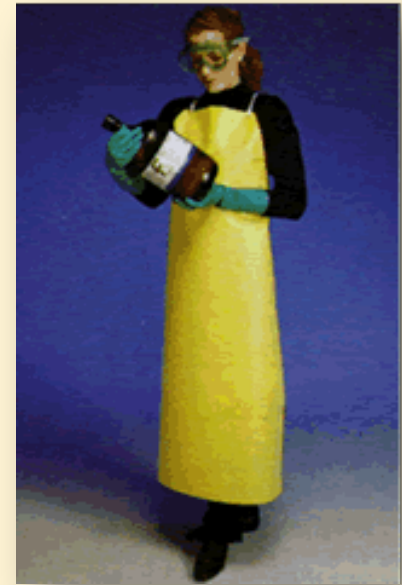
- ❖ A special face shield must be worn when working with acids and solvents
- ❖ Safety goggles or glasses must be worn to cover the eyes at all time
- ❖ The face shield is worn over the goggles or glasses



# PPE for the body

## Acid Aprons

- ❖ Extra protection is required above and beyond a cleanroom smock or bunnysuit when using acids or solvents
- ❖ In the case of a splash or spill, acid aprons can be removed quicker than a bunnysuit or smock
- ❖ Acid aprons are commonly made from a rubber based composite
- ❖ Aprons should be removed carefully to prevent any chemicals on the aprons from contaminating other areas



# More PPE for the Body

## Chemical Resistant Splash Suits

- ❖ Chemical resistant splash suits offer a high degree of protection against a wide range of chemical contaminants
- ❖ They are commonly used when cleaning hazardous material spills
- ❖ They are commonly made from Neoprene or a rubber based composite





# PPE for the Feet

- ❖ PPE protects the feet from chemical spills and dropped objects
- ❖ Cleanroom booties do not provide adequate protection
- ❖ Non-porous, closed toe shoes with a closed heel must be worn under the booties

## **Chemical Resistant Boots**

- ❖ Worn when cleaning up hazardous chemical spills



# Summary

- ❖ Manufacturing microsystems involves hazardous materials
- ❖ It is essential to understand the dangers involved and the proper PPE
- ❖ This SCO discussed the hazards in the workplace and the PPE needed to protect from any bodily injury
- ❖ When using PPE, it is also important to ensure that it is being used properly

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