

# **Clean room wet bench**

Vijayaraghavan.M.N

# **Semiconductor clean room**

Introduction, protocols, Do's and Don'ts

# Outline

- Aim
- What is clean room?
- Why clean room? IC fabrication
- Cleanroom protocols
- Do's and don't's

# **Aim**

Appreciation of micro/ nano electronic clean room practice so that

**You keep it clean**

**and**

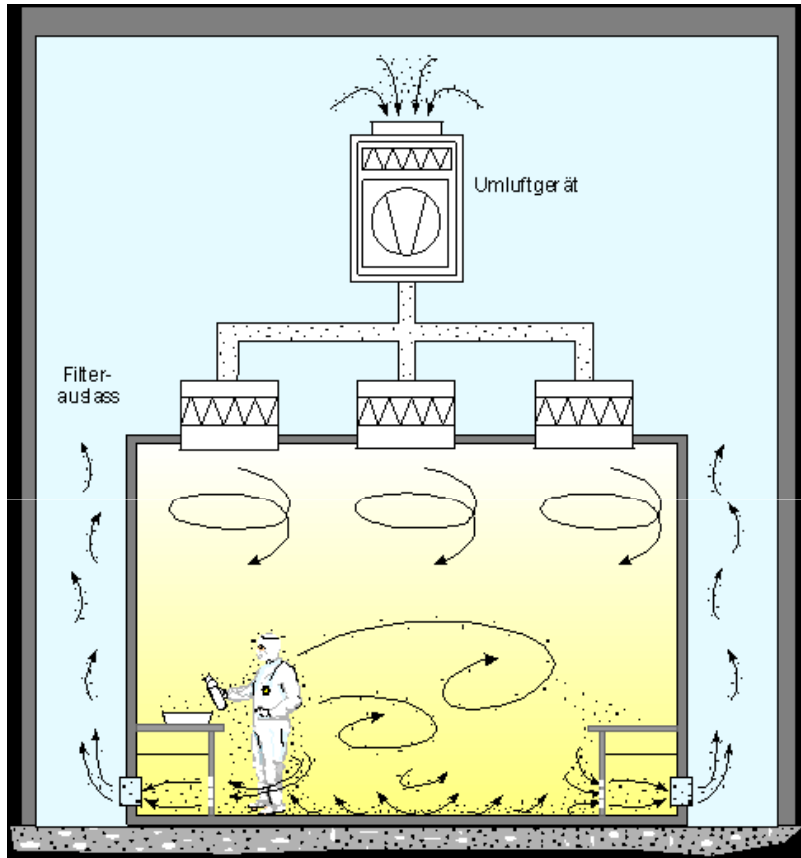
**Do reproducible research**

# **What is a Cleanroom?**

A clean environment designed to reduce the contamination of processes and materials. This is accomplished by removing or reducing contamination sources.

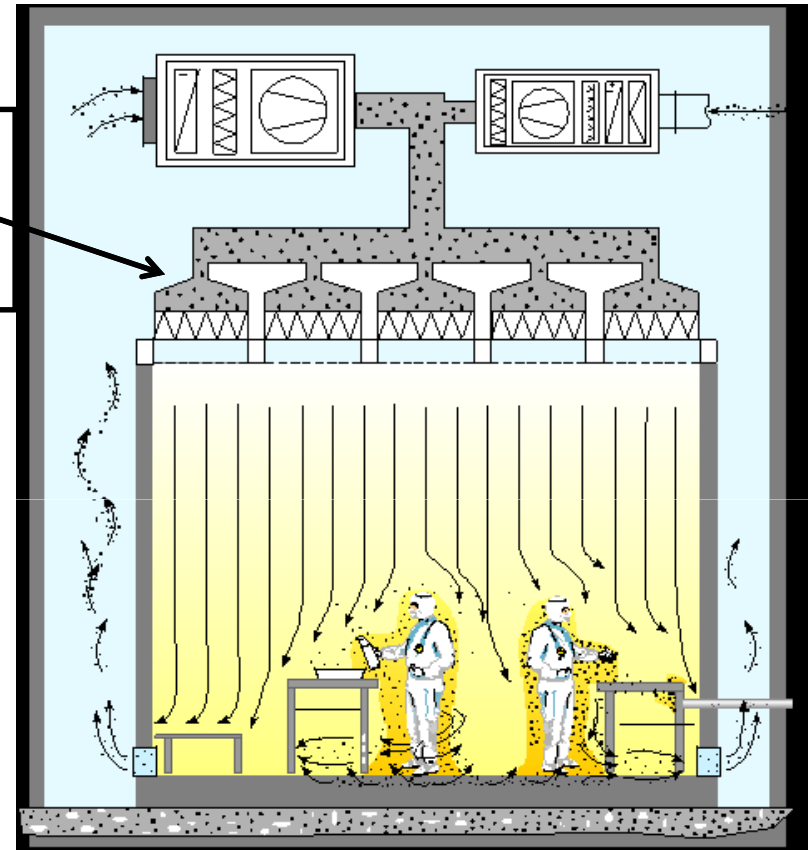
# Principles of the Clean Environment

Non-unidirectional



"dilution effect"- non-parallel /non-uniform flow streams and velocities. clean air entering the room and diluting the contaminated air.

Unidirectional - Laminar



"piston effect"- where incoming clean air "pushes" contaminated air from the room

# **CLEAN ROOM CLASS DEFINITION**

ROOM WITH AIR CONTAINING NO MORE THAN (n)  
PARTICLES PER CUBIC FOOT EQUAL TO OR  
LARGER THAN 0.5 MICRON.

(WHERE "n" IS 100, 1,000, 10,000, ETC.)

Class	maximum particles/ft <sup>3</sup>					ISO equivalent
	≥0.1 μm	≥0.2 μm	≥0.3 μm	≥0.5 μm	≥5 μm	
1	35	7	3	1		ISO 3
10	350	75	30	10		ISO 4
100		750	300	100		ISO 5
<b>1,000</b>				<b>1,000</b>	7	ISO 6
10,000				10,000	70	ISO 7
100,000				100,000	700	ISO 8



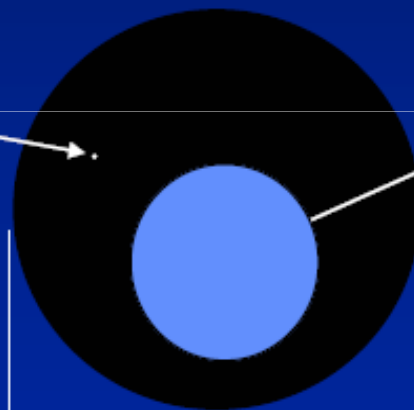
Class	maximum particles/m <sup>3</sup>						FED STD 209E equivalent
	≥0.1 μm	≥0.2 μm	≥0.3 μm	≥0.5 μm	≥1 μm	≥5 μm	
ISO 1	10	2					
ISO 2	100	24	10	4			
ISO 3	1,000	237	102	35	8		Class 1
ISO 4	10,000	2,370	1,020	352	83		Class 10
ISO 5	100,000	23,700	10,200	3,520	832	29	Class 100
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293	Class 1000
ISO 7				352,000	83,200	2,930	Class 10,000
ISO 8				3,520,000	832,000	29,300	Class 100,000
ISO 9				35,200,000	8,320,000	293,000	Room air

# RELATIVE PARTICLE SIZES

**MOST PARTICLES ARE TOO SMALL TO BE SEEN WITHOUT AID. THEIR SMALL SIZE RESULTS IN ELECTROSTATIC BONDING TO SURFACES**

**SIZE PARTICLE  
COUNTED IN  
CLEAN ROOMS.  
(0.5 MICRONS)**

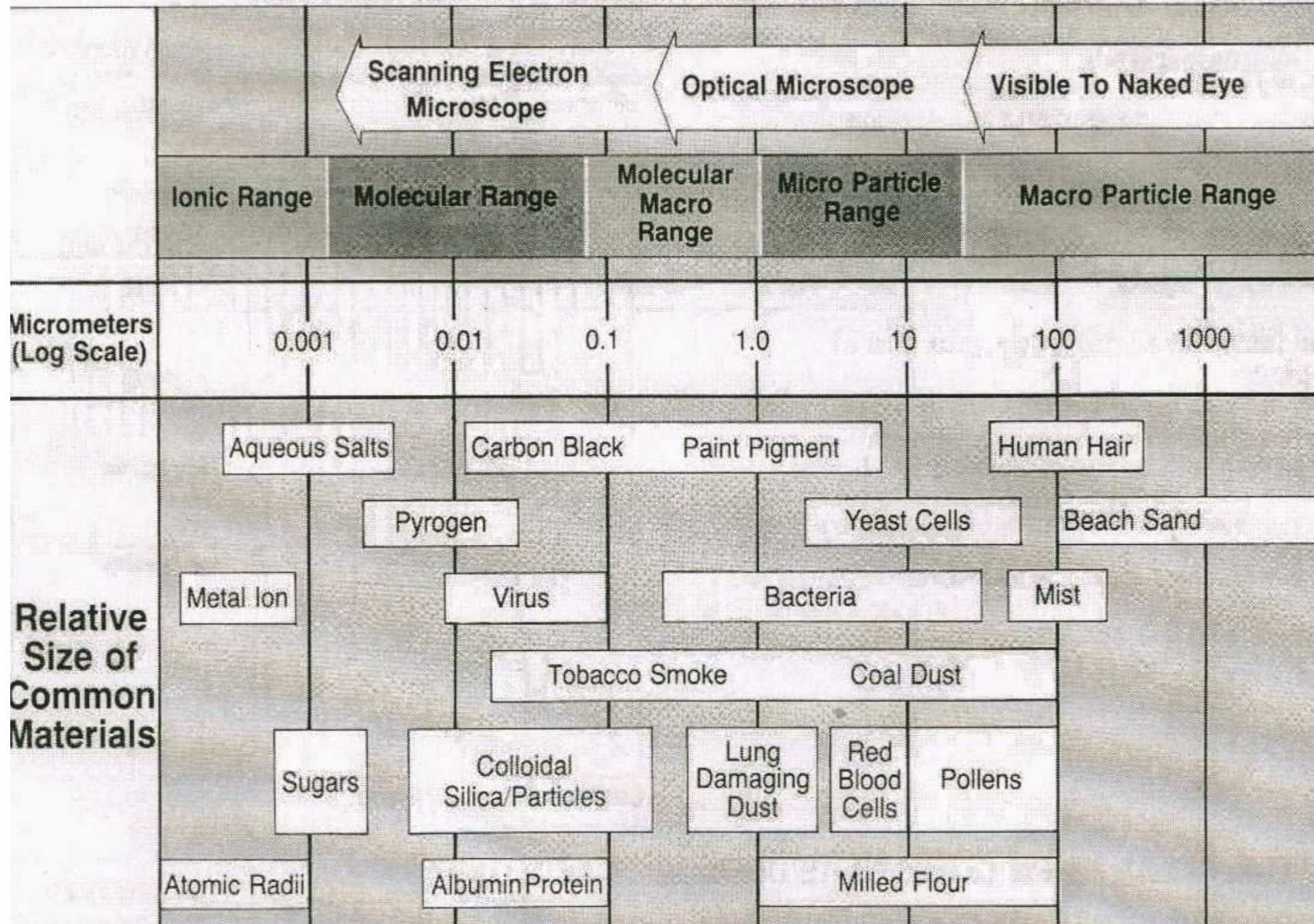
**SMALLEST SIZE  
VISIBLE TO EYE.  
(50 MICRONS)**



**HUMAN HAIR  
(100 MICRONS)**

**MEASURED  
PARTICLES ARE 100  
TIMES SMALLER  
THAN SEEN BY THE  
UNAIDED EYE**

# RELATIVE SIZE OF COMMON AIRBORNE CONTAMINANTS



# Contamination types

- Molecular contaminants
- Surface contaminants
- Particulate contaminants

*High contamination source ?*

# **MOLECULAR CONTAMINANT SOURCES**

- Out gassing
- Oil vapours
- Alcohols
- Paints, glues, & epoxies
- Aromatics; If you can smell it, suspect it as a contaminant



# **SOURCES of SURFACE CONTAMINATION**

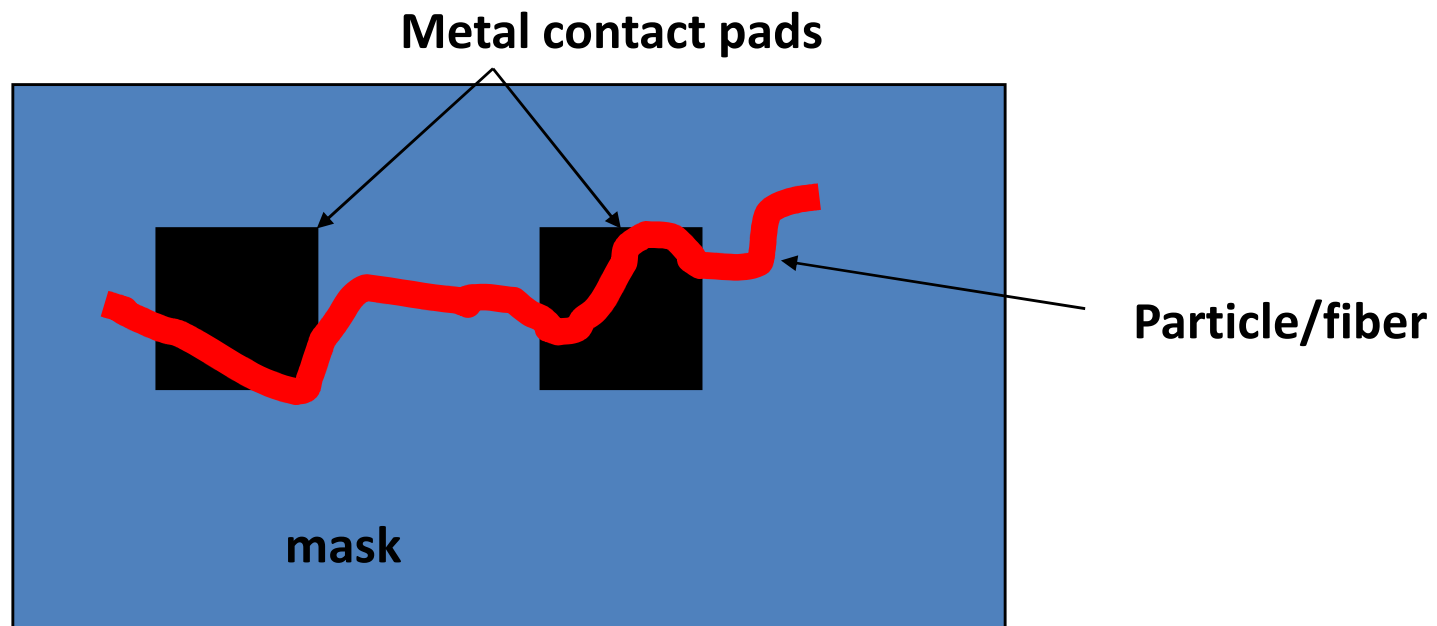
- Finger prints - Oil & grease
- Skin oil
- Hand cream
- Face cream, Wax
- Polish

# **SOURCES of PARTICULATES**

- People (skin, scales, hair, clothing lint, etc.)
- Particle shedding materials (cardboard boxes, paper)
- Abrading actions (drilling, sawing, sanding, etc.)
- Bare wood products

# Contaminant's impact

- Particle contamination
  - Patterning yield



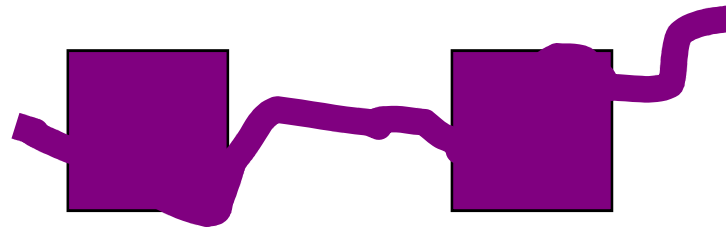


# Contaminant's impact

- Particle contamination
  - Patterning yield

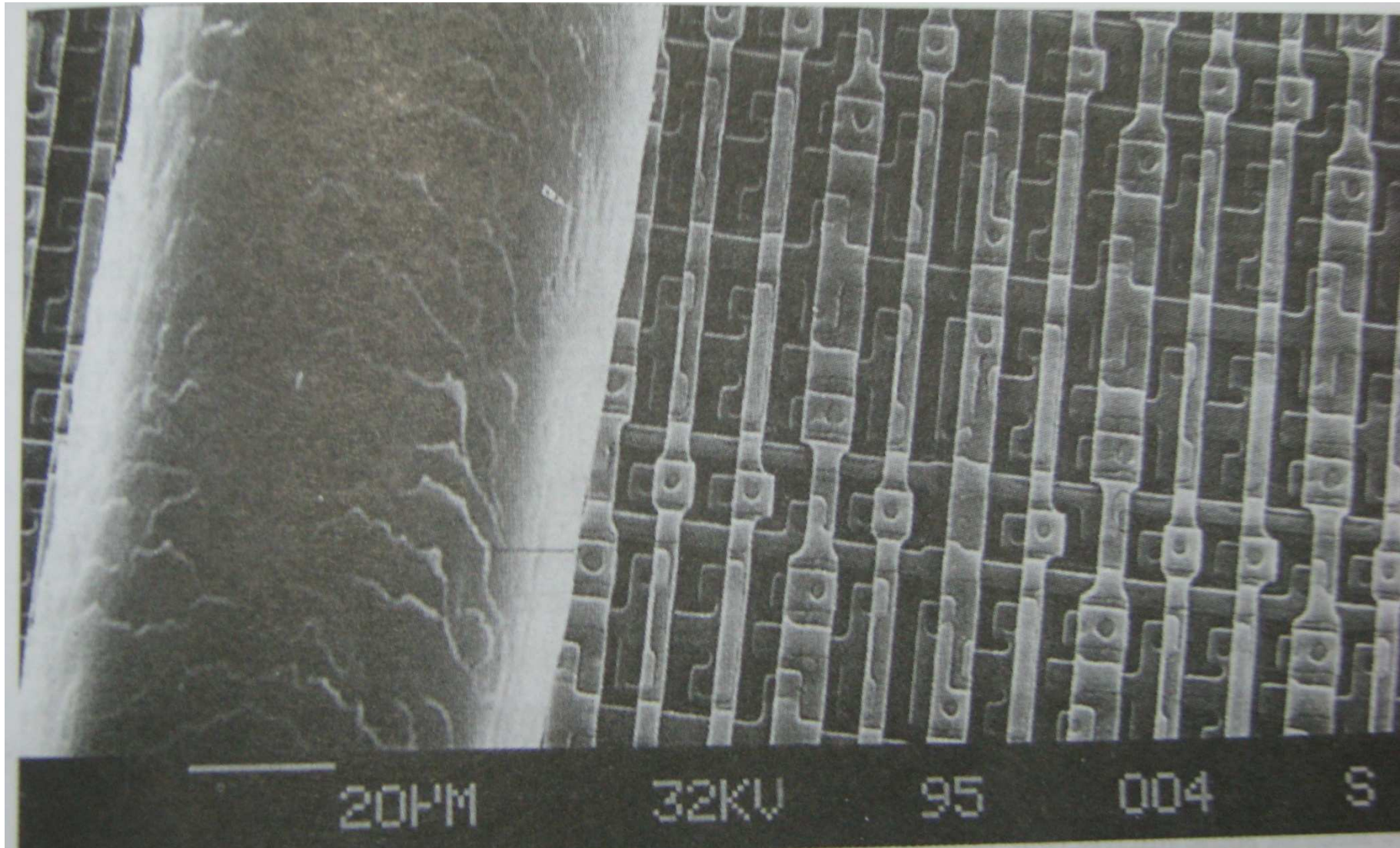


**What you wanted.**



**What you got.**

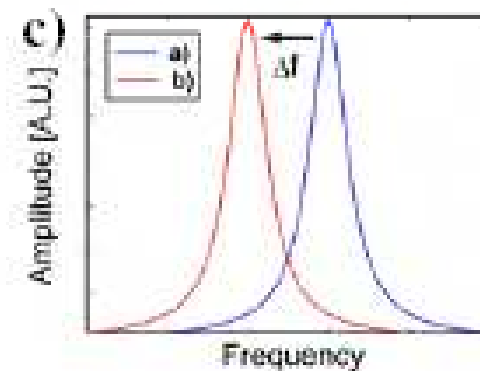
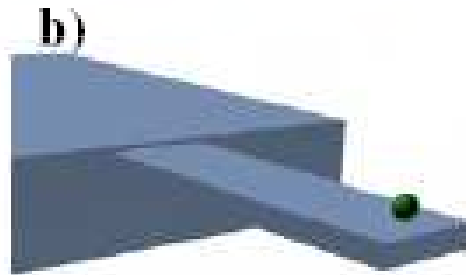
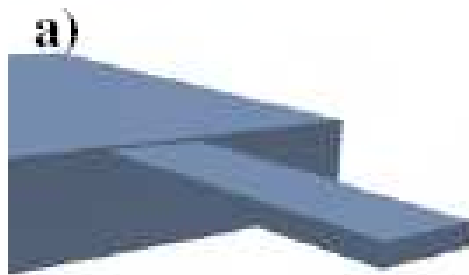
# Human hair on IC surface!



# Contaminant's impact

- Particle contamination
  - Cantilever
  - 1. Change in resonance frequency

$$1/f_1^2 - 1/f_0^2 = \Delta m / (4\pi^2 K)$$








- 2. Non linear response for Frequency Vs. Mass characteristics

Courtesy: Seena

# Contamination Sources

- People ~75%
- Ventilation ~15%
- Room Structure ~5%
- Equipment ~5%

# PARTICLE GENERATION ACTIVITY

ACTIVITY	*PARTICLES	DESCRIPTION OF ACTIVITY
	100,000	MOTIONLESS IN EITHER SITTING OR STANDING POSITION
	500,000	HANDS, FOREARMS, NECK AND HEAD MOTION
	1,000,000	HANDS, ARMS, TRUNK, NECK, HEAD MOTION AND SOME LOWER BODY MOTION
	2,500,000	SITTING TO STANDING OR VICE VERSA
	5,000,000 7,500,000 10,000,000	WALKING AT 2.0 MPH WALKING AT 3.5 MPH WALKING AT 5.0 MPH

# SIZE DISTRIBUTION of PARTICLES from SNEEZES or COUGHS

<u>DIAMETER</u>	<u>SNEEZE</u>	<u>COUGH</u>
• <1-1 $\mu\text{M}$	800,000	66,000
• 1-2 $\mu\text{M}$	686,000	21,000
• 2-4 $\mu\text{M}$	280,000	1,600
• 4-8 $\mu\text{M}$	134,000	1,290
• 8-16 $\mu\text{M}$	36,000	490
• +22 $\mu\text{M}$	4,500	85
<b>TOTAL</b>	<b>1,940,000</b>	<b>90,765</b>

# **Cleanroom protocols**



Hood/head cover  
Safety glasses  
Mask

Demos:  
[1](#), [2](#)

gloves

Cover all

Shoe cover

Sticky mat

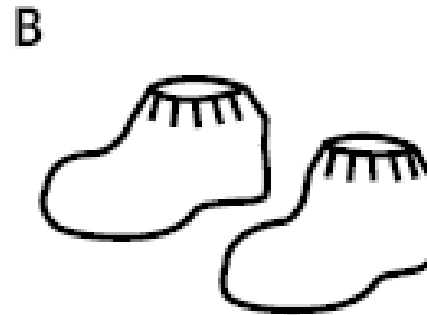


## Step 1: Pre-entry

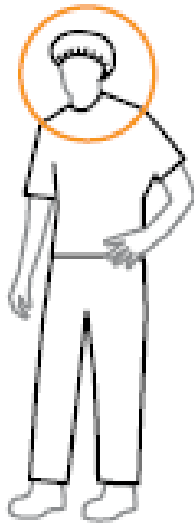
## Gowning procedure



**Bouffant/Hair Net**  
Be sure to contain  
all hair.



**Shoe Covers**  
Contain all laces and  
tassels.

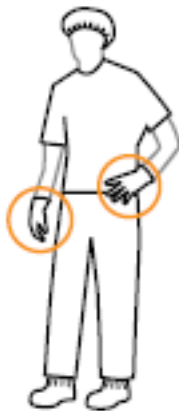


# Gowning procedure

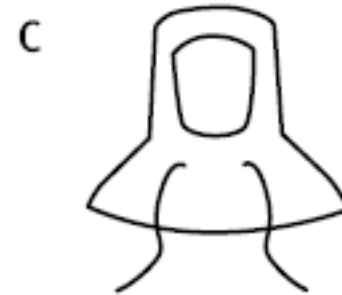
## Step 2: Gowning



**Gowning Gloves**  
Recommended for  
Class 100 and better.



**Mask**  
Worn under hood.  
Bend nosepiece first  
for a snug facial fit.



**Hood**  
Ensure snug fit and  
proper face/neck seal.



## Step 3

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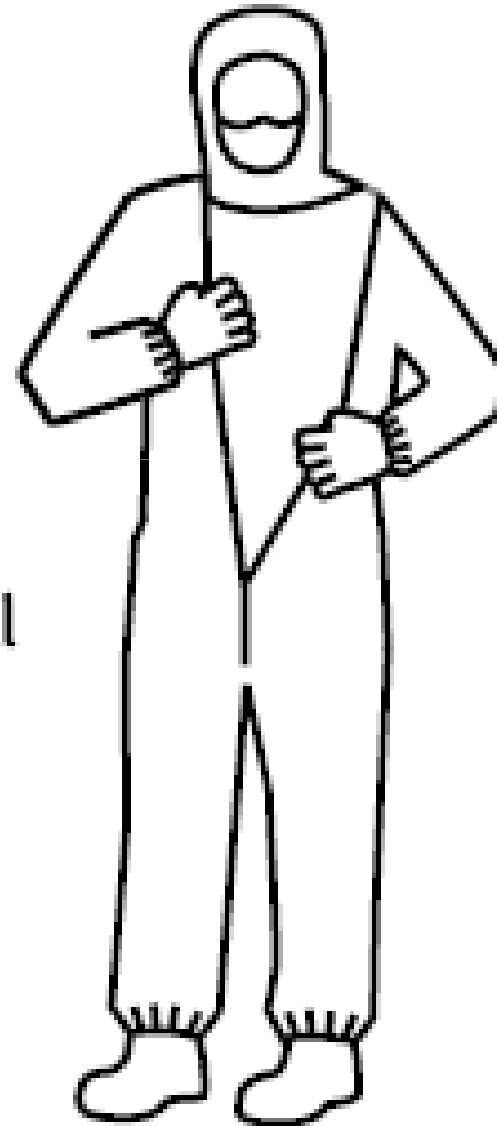
## Gowning procedure

### Coverall

Step into the coverall.

Be sure sleeves and upper garment do not touch bench or floor.

Tuck shoulder panels from hood inside coverall before zipping up.



# Gowning procedure

## Step 4

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### Boot Covers

Put on boots and pull boots (high-top shoe covers) over legs of coverall.



## Step 5

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### Goggles

Wear goggles/safety glasses when eye protection or additional particulate control is desired.



## Step 6

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### Second Sterile Gloves (optional)

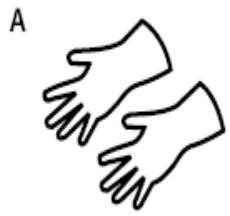
For maximum particulate protection, place hem of glove over cuff of sleeve.





# Gowning removal procedure

## Step 1: In order



**Gloves**  
If two pairs of gloves are worn, remove top pair of gloves then discard.



**Goggles/Safety Glasses**  
Remove and properly contain.



**Hood**  
Hang in controlled environment.



**Mask**  
Remove and usually discard.



**Boot Covers**  
Usually discard after each change.



# Gowning removal procedure

## Step 2

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### Coverall

If coverall is to be used again, either hang it in a controlled environment or prepare for storage.



## Step 3

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A



### Gloves

It is recommended that gloves be discarded after each change.

B



### Bouffant/Hair Net

Usually discard after each change.

C



### Shoe Covers

Usually discard after each change.

# Cleanroom Do's

- Only authorized personnel will be allowed inside the cleanroom.
- Only take what is necessary into the cleanroom.
- Only dedicated tools are allowed in the cleanroom.
- Gown in the prescribed manner over your non-frayed/non-ripped, low-linting clothes.
- Always make sure that all the head/facial hair is covered inside the cleanroom.
- When using an air shower, turn a minimum of three times around (slowly) during the ON cycle time.



# Cleanroom Do's

- Keep doors from clean room to gowning area closed.
- Keep the cleanroom garments closed at all times while in the cleanroom.
- Use pass-through properly.
- Maintain good air flow management. “Product gets air first.”
- Be discrete in coughing, sneezing, blowing your nose. If you can, go into the service area or gowning room.

# Cleanroom Don't's

- People who have not been trained properly to meet the cleanroom usage requirements will not be allowed inside the cleanroom. The Cleanroom supervisor has the last word.
- No cosmetics, tobacco products, handkerchiefs, tissues, food products, drinks,
- wooden/mechanical pen/pencils, perfumes, colognes, watches, jewellery, cassette players, phones, beepers, combs, cardboard or non-cleanroom approved papers are not allowed.

# **Cleanroom Don't's**

- Do not bring any tools/ equipment into the cleanroom from the maintenance shop to work in the cleanroom.
- No bare clothes are allowed inside the cleanroom.
- Do not expose any facial/head hair.
- Do not open the door to the cleanroom until the ON cycle of the air shower is over.

# Cleanroom Don't's

- Do not open the door to the cleanroom for communication or passing of products back and forth – use the [pass-through](#) instead.
- Do not use pass-through for storage.
- Do not block the air flow from the filter to the product.
- Do not congregate. No running and try to maintain silence

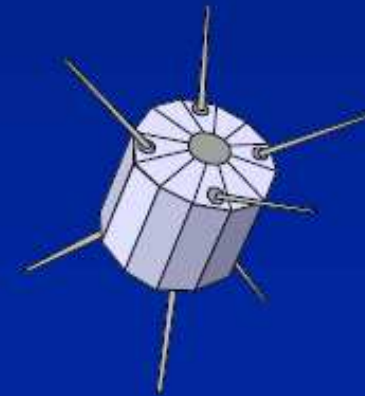
# THE BOTTOM LINE

## LIMIT

PEOPLE - ACTIVITY - MATERIAL



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# **Video links**

- <http://10.32.34.60/videolectures/CleanRoomVideos/>

