1. Cleanliness in Microfabrication

→ A requirement for success

a) Particles in the environment

→ dust, pollen, mold, dead skin cells, hair, etc.

→ consider that the average human hair is 100μm in diameter → imagine the result of 1 hair landing on a wafer of MEMS devices with 2μm features, during microfabrication

→ Many dust particles are electrically conductive

→ can short out electrical MEMS structures

→ Cleanroom suits are worn by microlab workers to minimize contamination from workers

→ hairnet

→ face mask

→ low dust cleanroom suit

→ booties

→ low dust gloves

b) Cleanliness Definition

Class X Cleanrom → less than X of 0.5μm or larger particles per ft^3

Ex: Class 1000 cleanroom: <1000 0.5μm+ particles per ft^3

Typical outdoor enviroment: ~ 400,000 particles per ft^3

Class	Fabrication Limit (feature size)
1000	4μm
100	1.25μm
10	0.7 μm
1	0,3 μm
0.1	<0.1 μm

→ Imagine the cleanliness required for sub-10nm devices <show paper>

→ most likely fabrication is 100% robotic → no people in the cleanroom

c) Besides Clean Air

→ high purity chemicals must also be used in microfabrication → expensive

a. Water

→ Water for use in microfabrication must be "deionized"

→ Ions in water (particularly Na) can migrate into Si and other materials, contaminating them

→ Deionized water is called "DI water"

→ Tap water resistivity ~ 50 kΩ-cm

DI water resistivity ~ 18 MΩ-cm

↑ Note textbook has error in units, p. 34