

Solid State Sensors

Tour of a Microfabrication Lab

8/31/22

Microfabrication Lab Safety

- Dangerous chemicals and equipment used

- Safety is VERY important

- Poisoning
- Burns
- Cuts
- Electrocution
- Irradiation
- Death

- Chemical safety

- Acids – severe burns
- Toxic liquids and gases



- Flammable liquids
- Explosive potential

- Equipment safety

- High voltage
- UV / X-ray radiation
- High pressure
- High/low temperatures
- Glassware (sharp if broken)

- Proper clothing required

- Clean room suit
- Protective gloves
- Safety goggles

A Microlab when Safety is Ignored



Cleanliness

- Very important in microfabrication
- 100 μm width human hair: 10 μm device feature
- Class X cleanroom: less than X 0.5 μm particles per cubic foot
 - Ex: Class 10,000: < 10,000 0.5 μm particles per ft³
- AU microlab:
 - Class 1000/2000 in open areas
 - Class 100/200 in photolithography room

Typical Cleanroom Clothing



Low particulate
cleanroom suit

Hair net

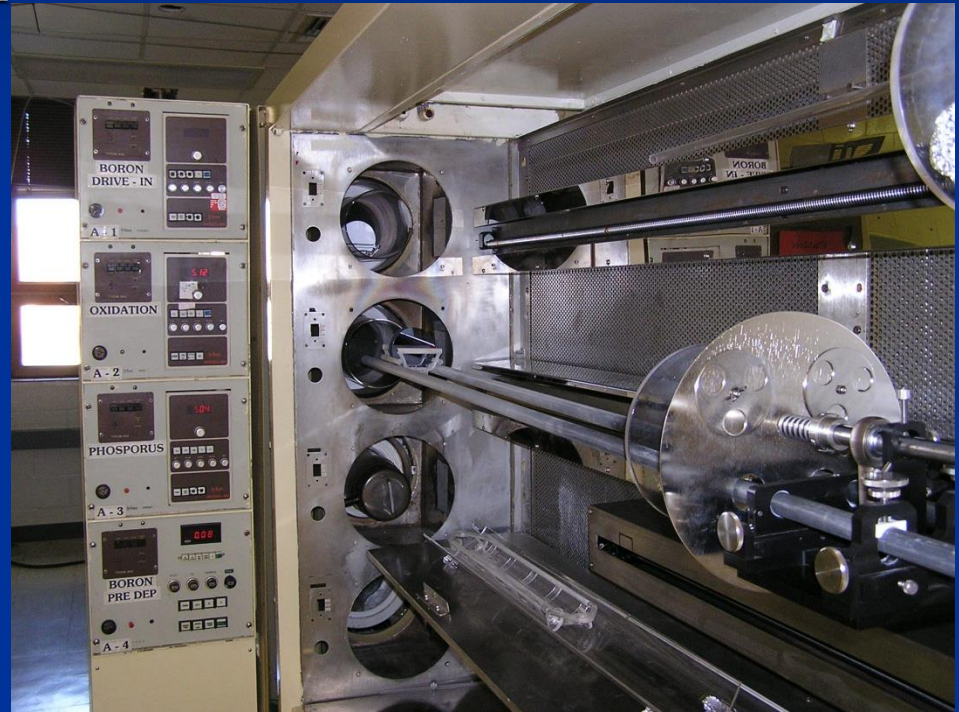
Safety glasses
required when
working with
chemicals

Protective gloves

Booties

Oxidation and Diffusion Furnace

- For thermally growing Silicon Dioxide (SiO_2) on Si wafers
 - Uses an oxygen torch and a hydrogen torch
 - Oxidation process
- For diffusion doping of Si wafers
 - To make n-type or p-type regions
 - Such as piezoresistors



Oxidation and Diffusion Furnace

LPCVD System

- “Low Pressure Chemical Vapor Deposition”
- For growing a layer of polysilicon on a wafer
- Also for growing a layer of silicon nitride on a wafer
- Typically thin films, $\leq 5\mu\text{m}$ thick



LPCVD System

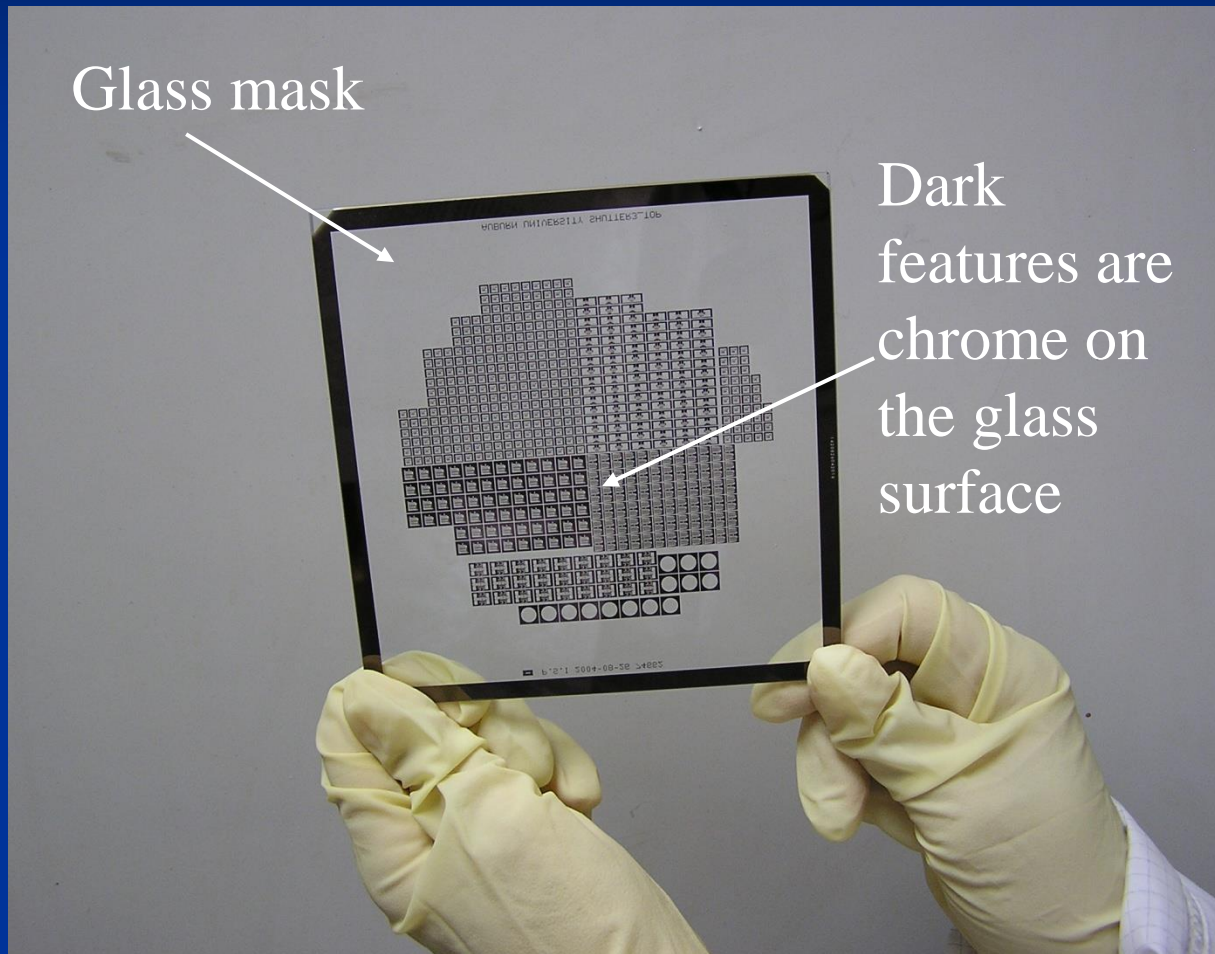
PECVD System

- “Plasma Enhanced Chemical Vapor Deposition”
- Low temp Si dioxide (LTO) deposition
- Low temp silicon nitride (SiN) deposition
- Deposition of other conformal thin film coatings via plasma processing



PECVD System

Photograph of a Photolithography Mask



Spinner for Applying Photoresist to a Wafer



Photograph of a MA/BA6 Mask Aligner



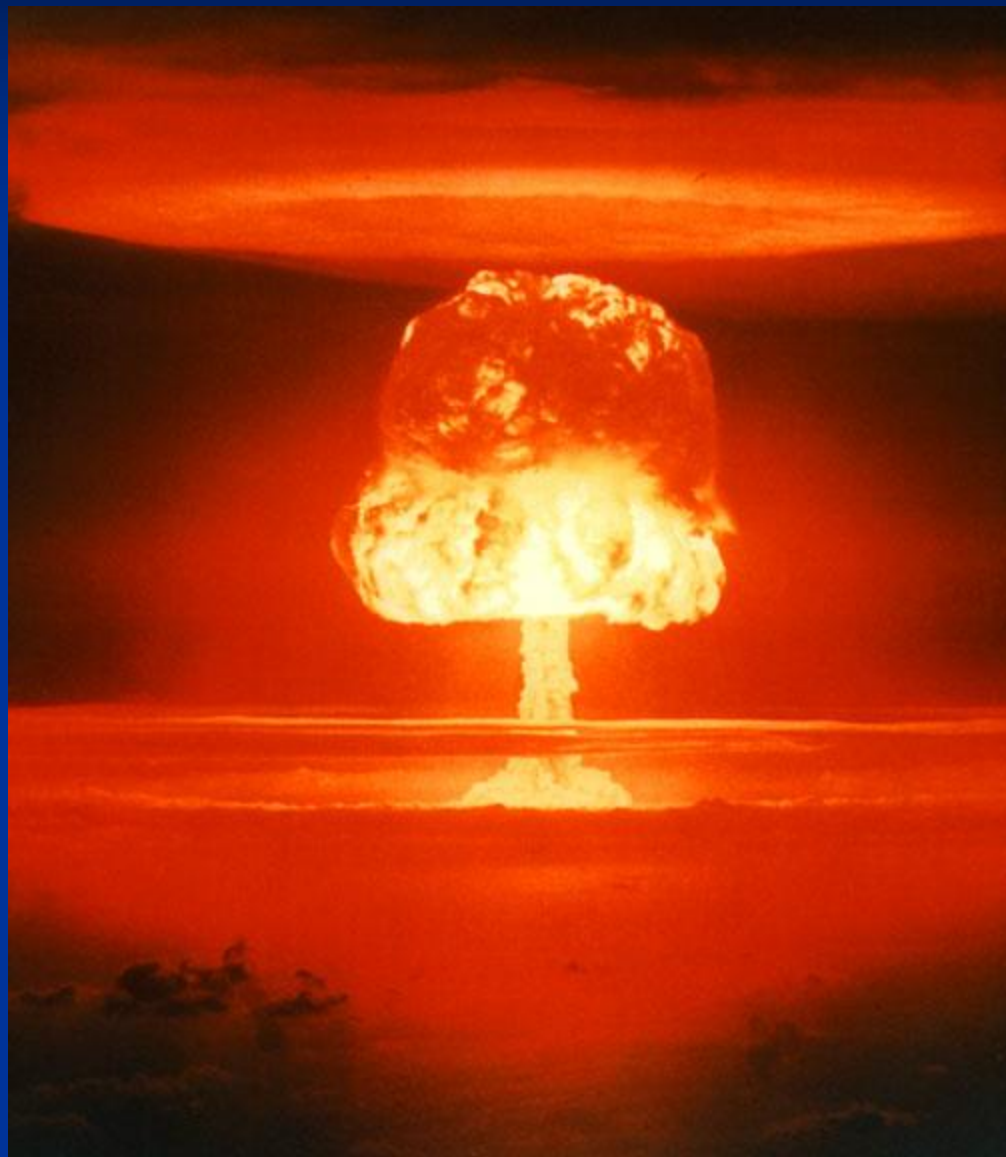
Wet Chemical Processing



Vapors are pulled up and out of the lab through a ventilation hood

Acids and solvents processed separately

When Acids and Solvents Mix



Removing Used Photoresist

- Can be removed chemically using solvents such as acetone
- Can be removed by Ashing
 - An oxygen plasma treatment that burns organics off the surface



Matrix Asher

Sputtering and Electron Beam Deposition

- Has 2 electron beam guns and one sputtering gun
- Holds 1 sputter target and 7 E-beam targets
 - Can deposit 8 different materials without breaking vacuum
- With the 2 E-guns, can co-deposit 2 materials at the same time
 - Can deposit alloys on a substrate



Typical cleanroom suit

Mark 50

STS Advanced Silicon Etcher

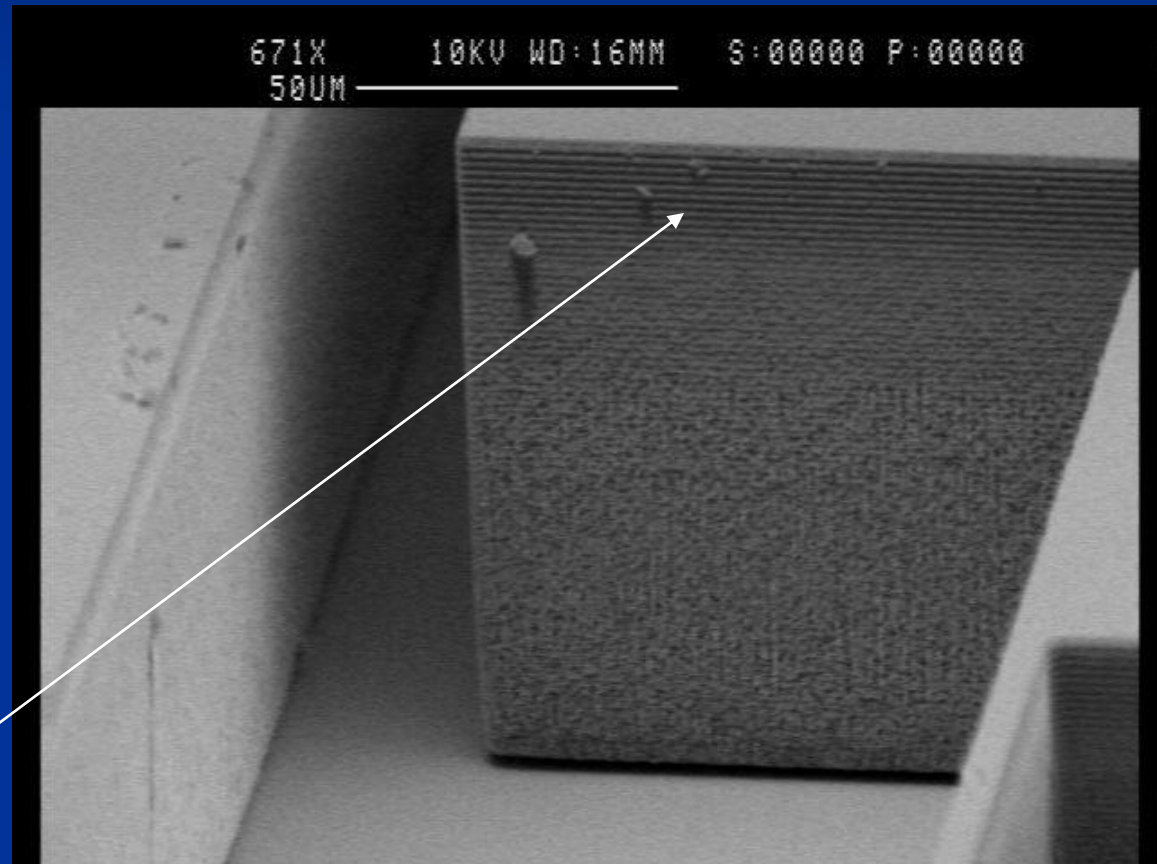
- Bosch process DRIE etcher for Si wafers
- Holds 4" diameter wafers
- Can obtain a 10:1 aspect ratio when etching through a Si wafer
- Real “workhorse” for many MEMS fabrication projects



STS ASE Bosch Process Si DRIE
Etcher

A Dry Etched Si Wall

Bosch dry etching process results in horizontal micro trenches on vertical surfaces



STS Advanced Oxide Etcher

- Non-Bosch process RIE system for non-Si materials:
 - Glass
 - Titanium thin films
 - plastics



STS AOE RIE Etcher

Profilometer

- Measures the depth of etched features
- Used along with RIE to determine when the desired etch depth has been reached



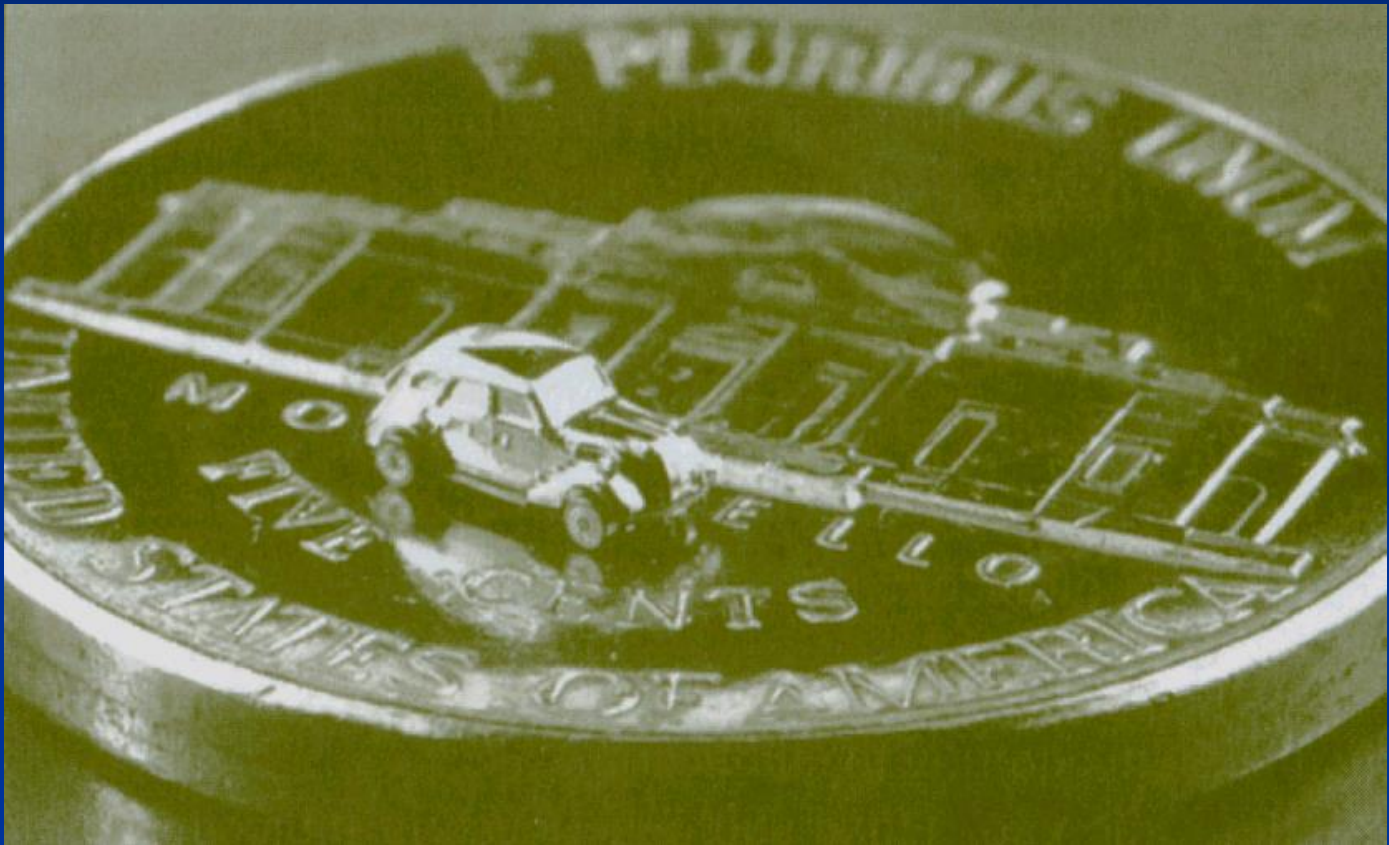
Electroplating System

- Electroplating used to grow metal micro-structures
- Cu, Ni, Au, Sn, etc. can be electroplated

Wafer Plating System



Plated Working Electric Car



Courtesy: Denso Corp

Polyimide Processing

- Polyimides are special plastics
- Wafers can be coated with polyimide layers
- The polyimide can then be cured in this special vacuum furnace



Polyimide Vacuum Curing Oven

Automated Dicing Saw

- Dices a wafer into die
- Uses a diamond saw blade
- Water cooled
- Wafer attached to a tape to hold die in place



Karl Suss Flipchip Bonder



Finished die are placed into position with a precision x, y, θ vacuum chuck, and heat is used to bond them into packages

Automatic Thermosonic Wire Bonder

- Die are wire bonded to package pads for electrical connections
- Gold wire bond wire is used ($\sim 25\mu\text{m}$ diameter)



Photo of Wire Bonds

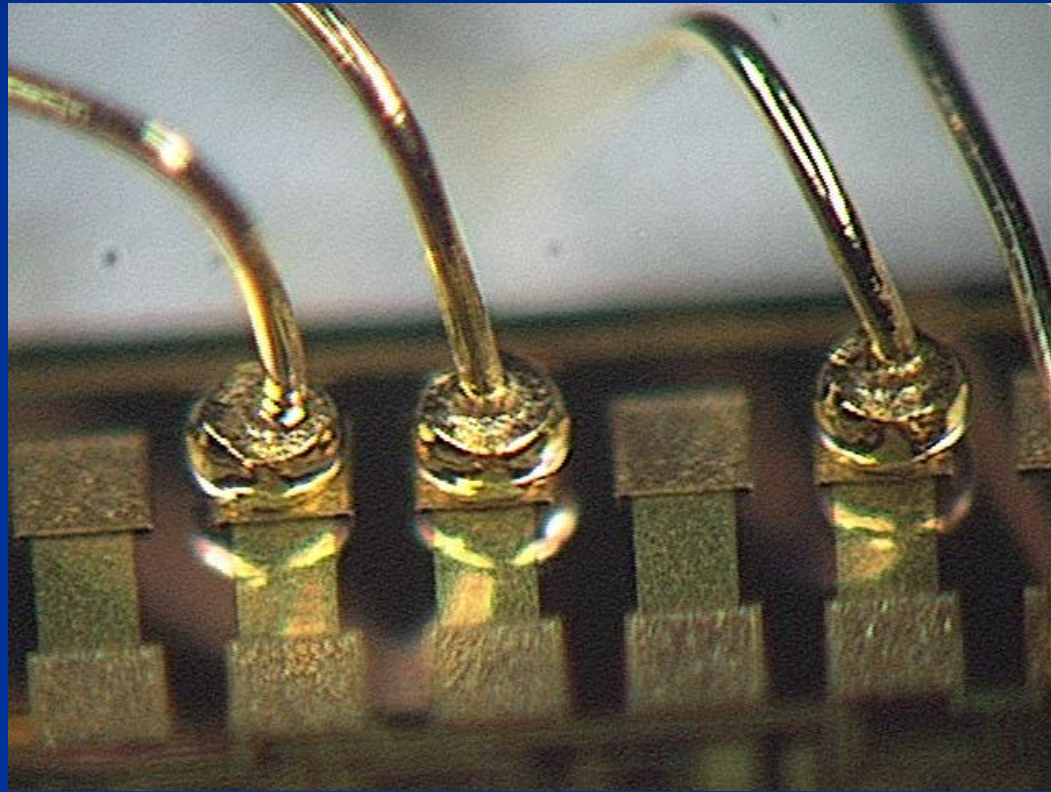


Photo of a Commercial Microfabrication Facility



ST Microelectronics

<http://france3-regions.francetvinfo.fr/auvergne-rhone-alpes/pas-suppression-usines-france-annonce-st-microelectronics-sites-grenoble-crolles-sont-circonspects-862743.html>

The End