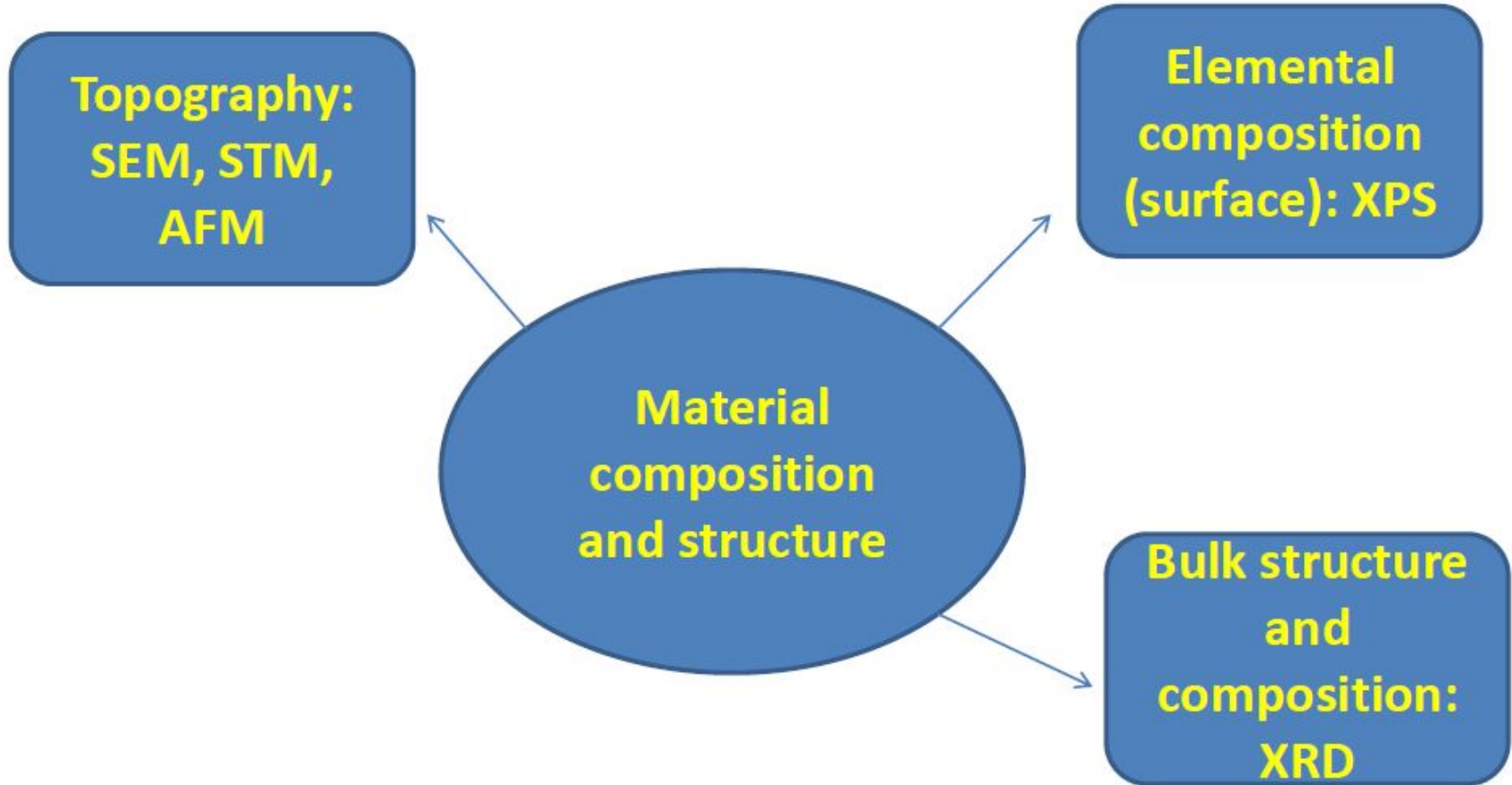




## **Characterization and Back End Processes**

PROCESS STEP USED	MEASURED ATTRIBUTE	METROLOGY SYSTEM
Si manufacturing	resistivity	4-point probe, eddy current
Inspection of incoming wafers	flatness defects: particles micro-scratches crystalline defects haze	flatness tester defect inspection system  ↓
Si epitaxy	resistivity thickness	4-point probe, eddy current FTIR
Conductor deposition (PVD, MOCVD)	resistivity particulate contamination	4-point probe, eddy current defect inspection system
Dielectric deposition (CVD)	thickness, RI stress particulate contamination dielectric constant	reflectometer, ellipsometer stress gauge defect inspection system C-V tester
Dopant processes (ion implant, diffusion)	uniformity depth profile	4-point probe, thermal wave, FTIR SIMS, SRP
Planarization	removal rate and uniformity local/global planarity slurry particles, micro-scratches	reflectometer, ellipsometer surface profiler (high resolution) defect inspection system
Etch	removal rate and uniformity etch selectivity etch profile particulate contamination pattern defects	reflectometer reflectometer SEM, AFM defect inspection system defect inspection system
Lithography	critical dimension overlay pattern defects particulate contamination	SEM optical overlay tool defect inspection system defect inspection system
Yield monitoring	correlation of metrology and inspection results to yield	fab-wide data management system

Information needed about the structure and composition (surface and bulk) of materials: *microscopic* and *nanoscopic* domains!



# Scanning Electron Microscopy (SEM)



**Do it with electrons !**

## **1.1 Characteristic Information: SEM**

### **Topography**

The surface features of an object or "how it looks", its texture; direct relation between these features and materials properties

### **Morphology**

The shape and size of the particles making up the object; direct relation between these structures and materials properties

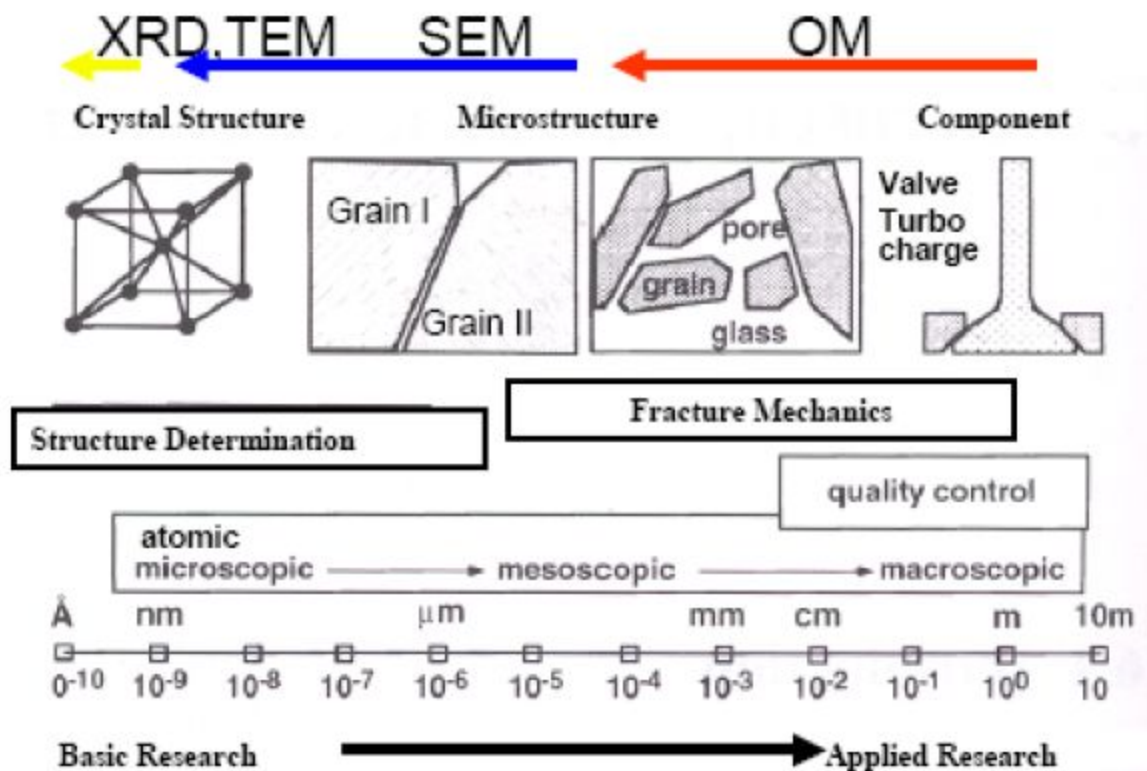
### **Composition**

The elements and compounds that the object is composed of and the relative amounts of them; direct relationship between composition and materials properties

### **Crystallographic Information**

How the atoms are arranged in the object; direct relation between these arrangements and material properties

# Scale and Microscopy Techniques



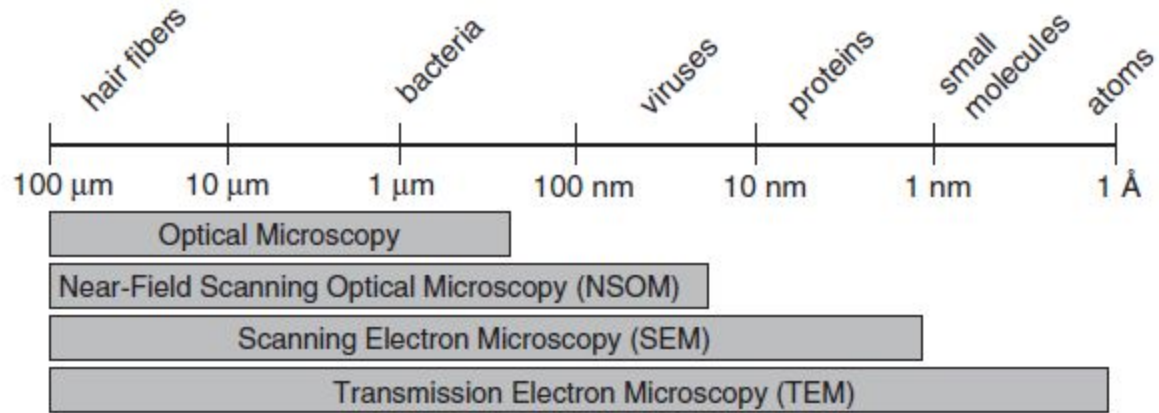
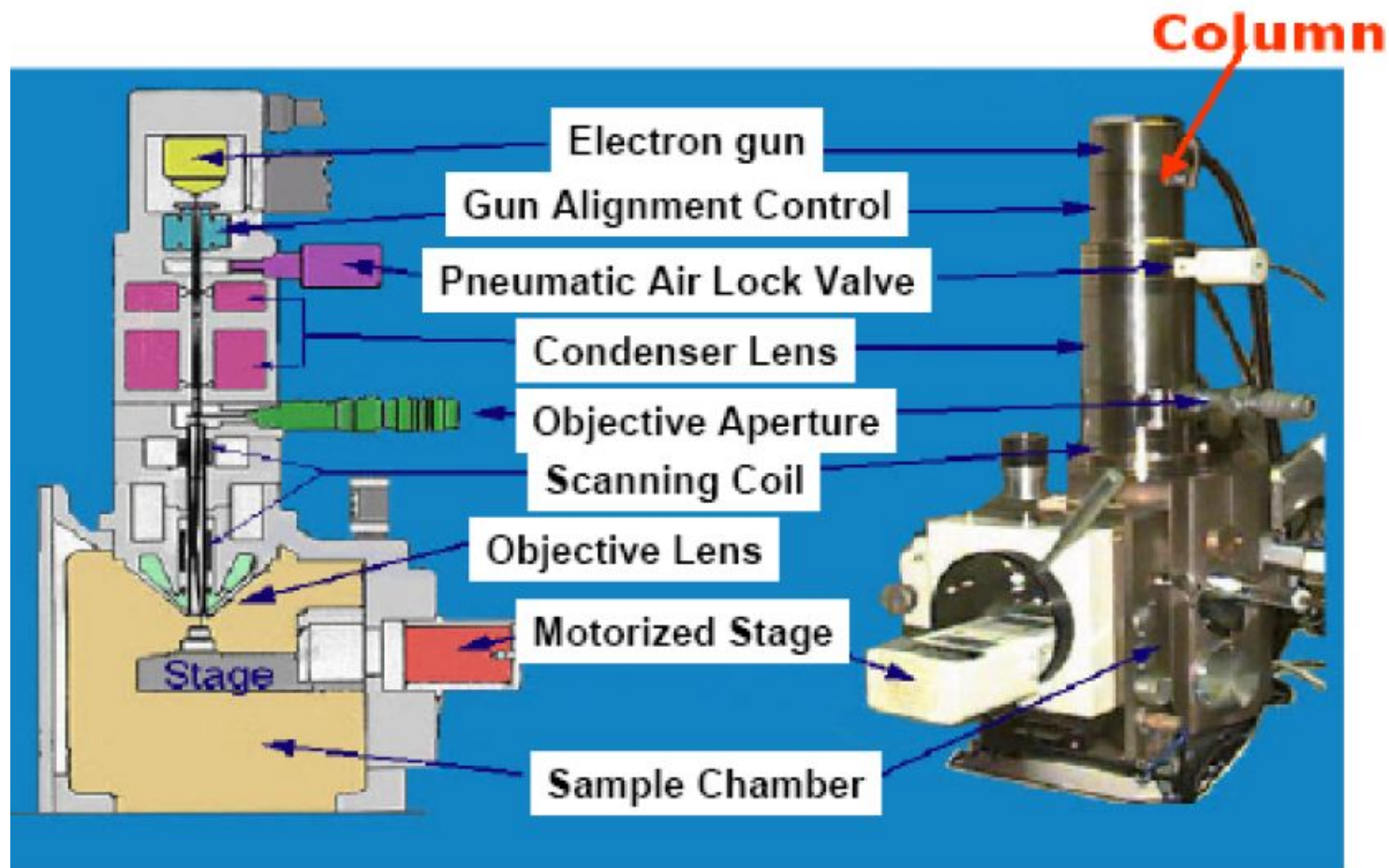
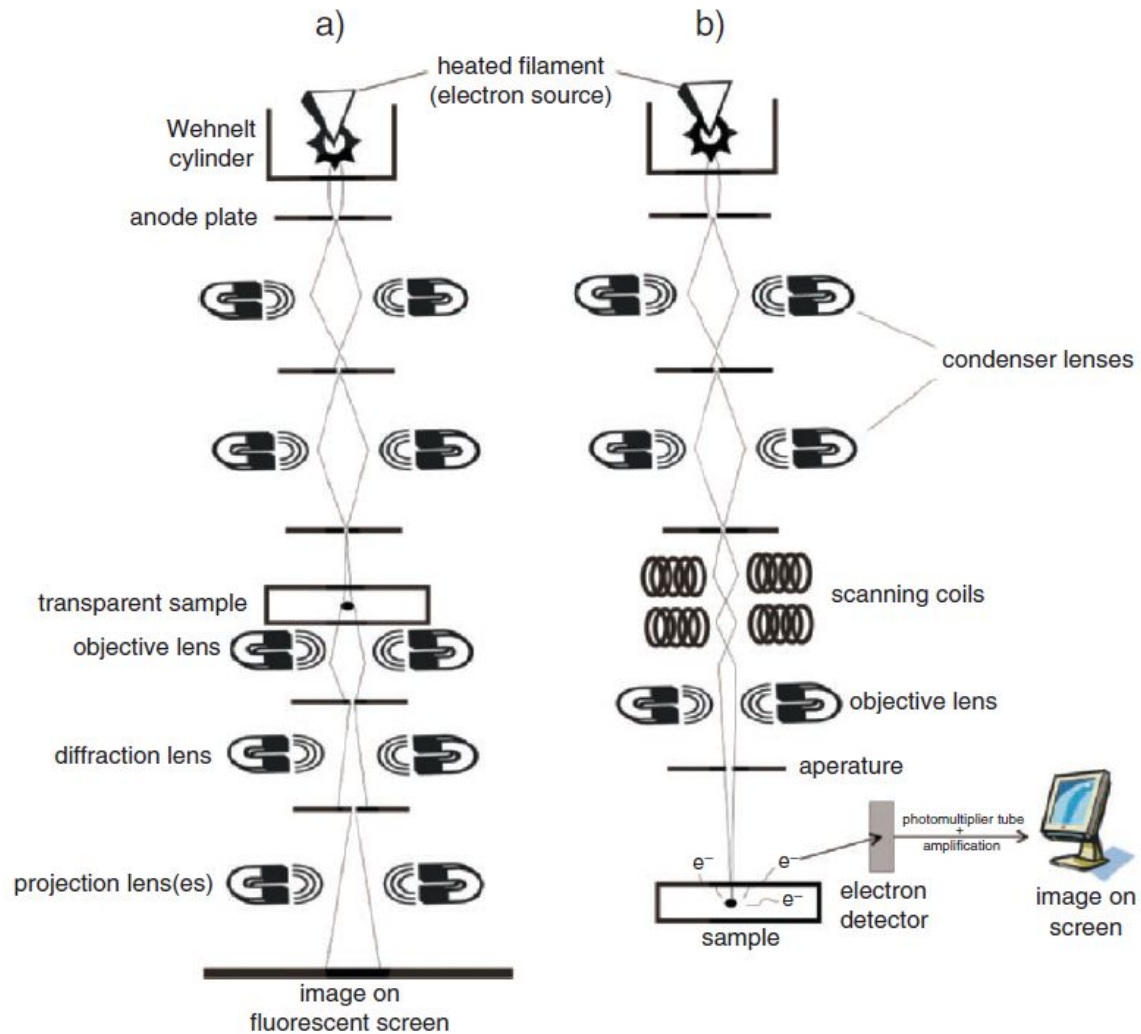


Figure 7.3. Comparison of the characterization size regimes for optical and electron microscopy.

# A Look Inside the Column







# Summary of Electron Microscope Components

## 1. Electron optical column consists of:

- electron source to produce electrons
- magnetic lenses to de-magnify the beam
- magnetic coils to control and modify the beam
- apertures to define the beam, prevent electron spray, etc.

## 2. Vacuum systems consists of:

- chamber which “holds” vacuum, pumps to produce vacuum
- valves to control vacuum, gauges to monitor vacuum

## 3. Signal Detection & Display consists of:

- detectors which collect the signal
- electronics which produce an image from the signal

# Sample Preparation

## Sample Coating

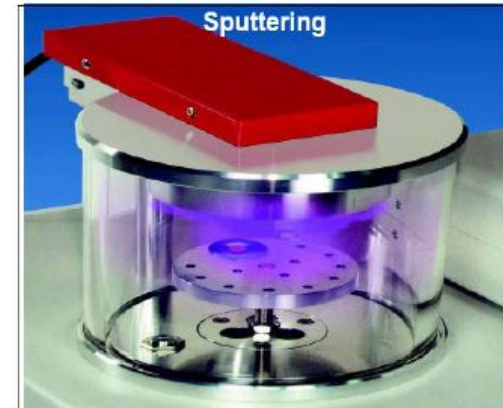
Q: Why ?

A: Charging:

- Deflection of SE's
- Increased emission of SE's in cracks
- Periodic SE bursts
- Beam deflection

Solutions:

- Sputter coating with C, Cr, or Au-Pd
- Carbon tape, carbon paint, In foil



EDAX Genesis Spectrum Image Maps/Line Multi Point

File Edit View Collect Display Process MultiField Setup Window Help

Analyzer: Det 1 Preset: None App Time: 6.4 uS

Standardless Quantitative Data

Matrix Correction: ZAF

Element	Wt%	At%
OK	40.28	53.21
AlK	59.72	46.79

KV: 20.0 Mag: 5342

Reso: 1024x800

Strip: 25

Conti

BSE: 1 0 4095 16

Label: Det Smin Smax Reads

Peak ID HPD

Element: AuM Z Z+

K  AlK

Add Possible

Delete O Ka

Del All I Ma

Z List I Mz

EPIC I Mz

CrLi

CrLg

YLb

Alpha Lines Only

Elem  Shell  Trans

Markers

Abs  Esc  Sum

Advanced...

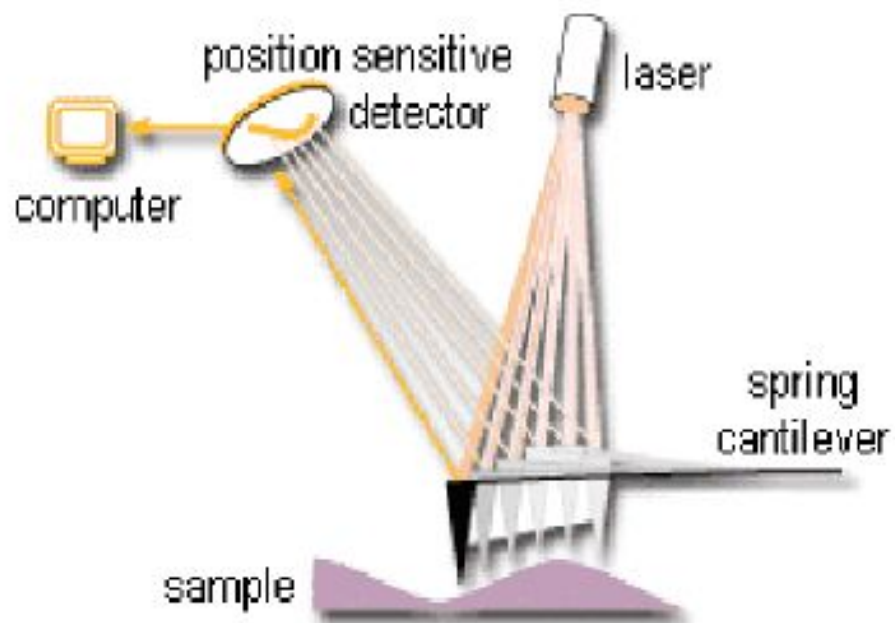
O Ka

Al Ka

0.30 0.60 0.90 1.20 1.50 1.80 2.10 2.40 2.70 3.00 3.30 keV

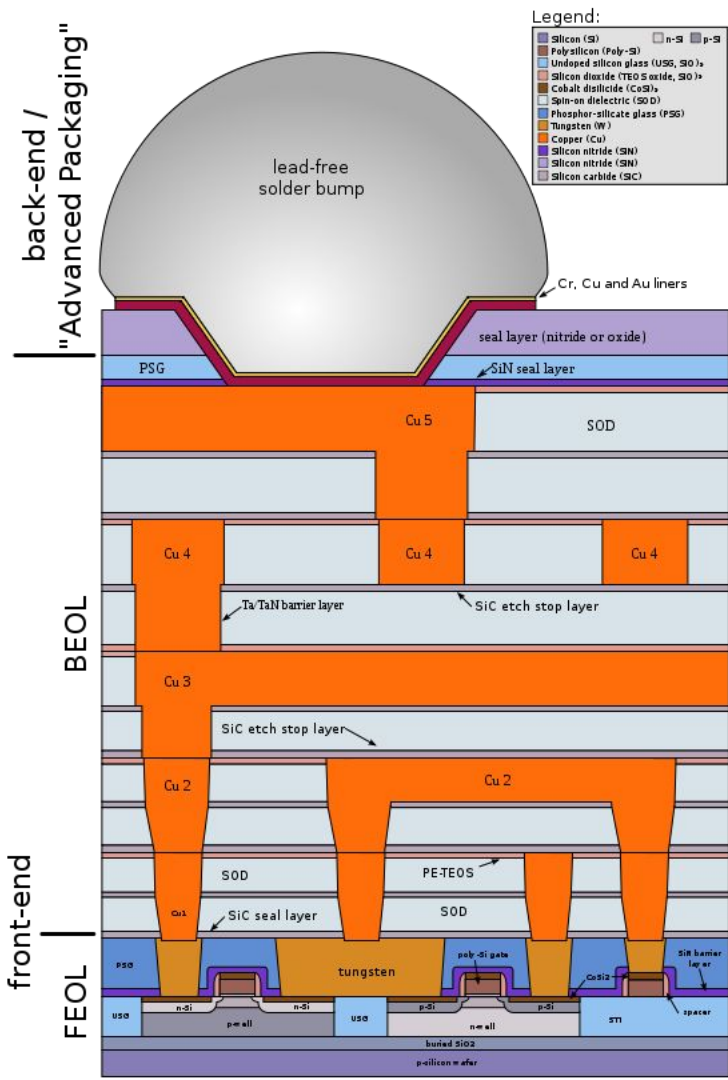
CPS: 17226 DTX: 19 Lsc: 160.3 Cnts: 31304 keV: 0.510 FS: 146874

start STORE N GO (F) untitled - Paint Microsoft PowerPoint ... Genesis Imaging/Map... 2:26 PM



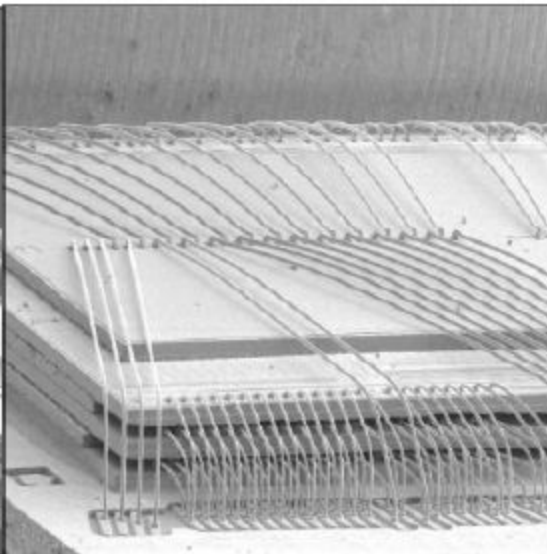
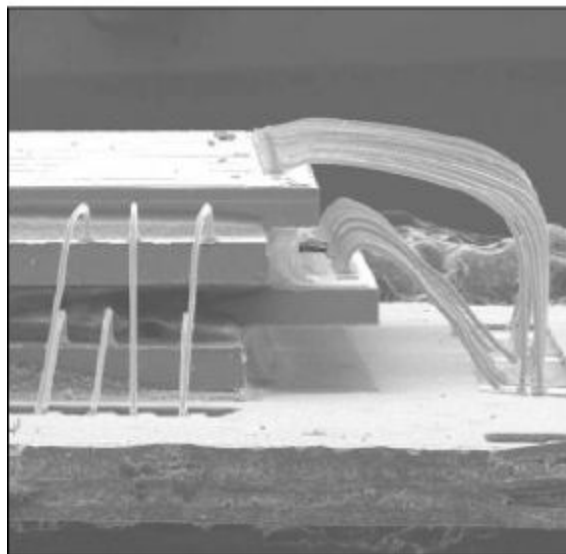
**Figure 2.3** *Diagram showing the working of and AFM cantilever [7].*

# BEOL vs FEOL



## Wire Bonding

Wire bonding is an interconnect technology where the chip's active side is facing up and a wire connects the electrodes on the chip to the substrate's electrodes. It is a current standard interconnect in industry. Often for testing, an IC ceramic socket is used to make signals from the chip to the test setup easier. A die attach material is needed to keep the chip in place as well as thick enough electrodes to absorb the energy during a bond. It is recommended to have at least a xxx nm Au layer on top of the electrode for wire-bonding purposes. Also after wire-bonding, a protective parylene coating can be used.





2min TEM (only need first half roughly) <https://www.youtube.com/watch?v=fQJYuTpK8Fs>

2min SEM (skim) <https://www.youtube.com/watch?v=KfQ4VNpWN4M>

9min SEM (skim) with EDS at end <https://www.youtube.com/watch?v=GY9lfO-tVfE>

Interesting SEM images: <https://www.youtube.com/watch?v=zmQ3Qb7Cq7M>

4min Ellipsometry to talk over and skim <https://www.youtube.com/watch?v=BycPkRIutqg>

AFM Wiki w Video and Images [https://en.wikipedia.org/wiki/Atomic-force\\_microscopy](https://en.wikipedia.org/wiki/Atomic-force_microscopy)













