

Fundamental of Electronics (FOE)

UNIT-5

ELECTRON MICROSCOPY

KALYAN ACHARJYA

kalyan5.blogspot.in

UNIT 5

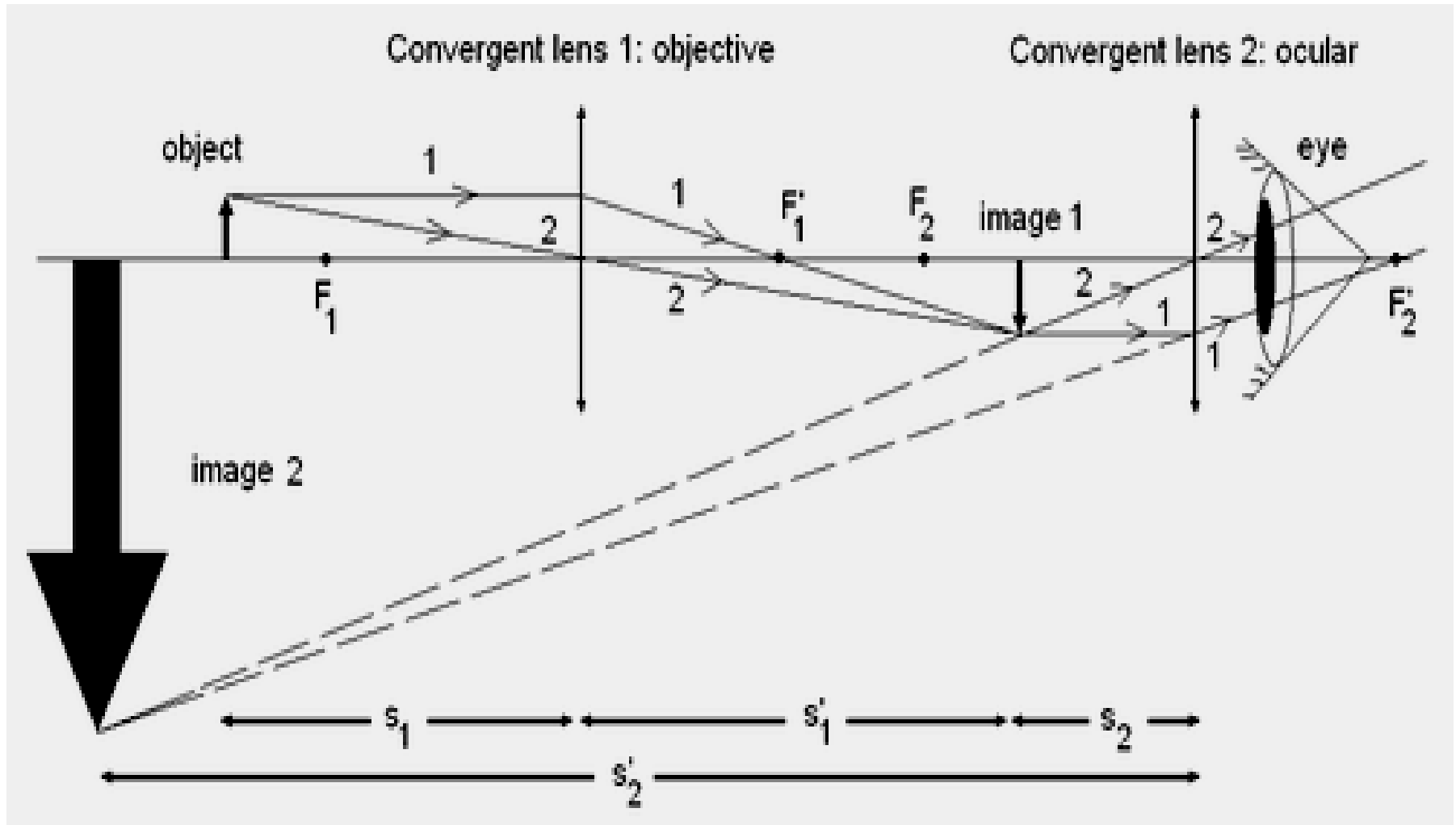
- ▶ **Electron Microscopy**
- ▶ Introduction to Nanotechnology



MICROSCOPE



How Compound Microscope Magnify:

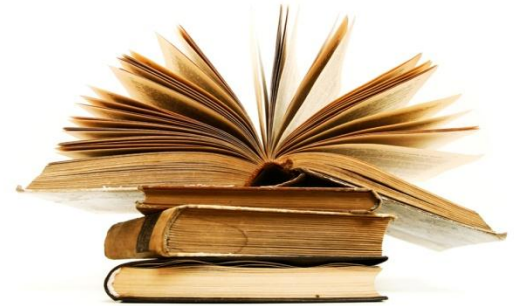
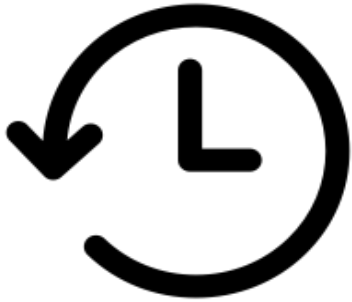


Microscopy

- ▶ A microscope - Greek: **micron** = small and **scopos** = aim
- ▶ **MICROSCOPE** - An instrument for viewing objects that are too small to be seen by the naked or unaided eye.
- ▶ **MICROSCOPY** - The science of investigating small objects using such an instrument is called microscopy.



Historical Background



- ▶ **1590** - Hans Janssen and his son Zacharias Janssen, developed first microscope.
- ▶ **1609** - Galileo Galilei - *occholino* or compound microscope.
- ▶ **1620** - Christian Huygens, another Dutchman, developed a simple 2-lens ocular system that was chromatically corrected.

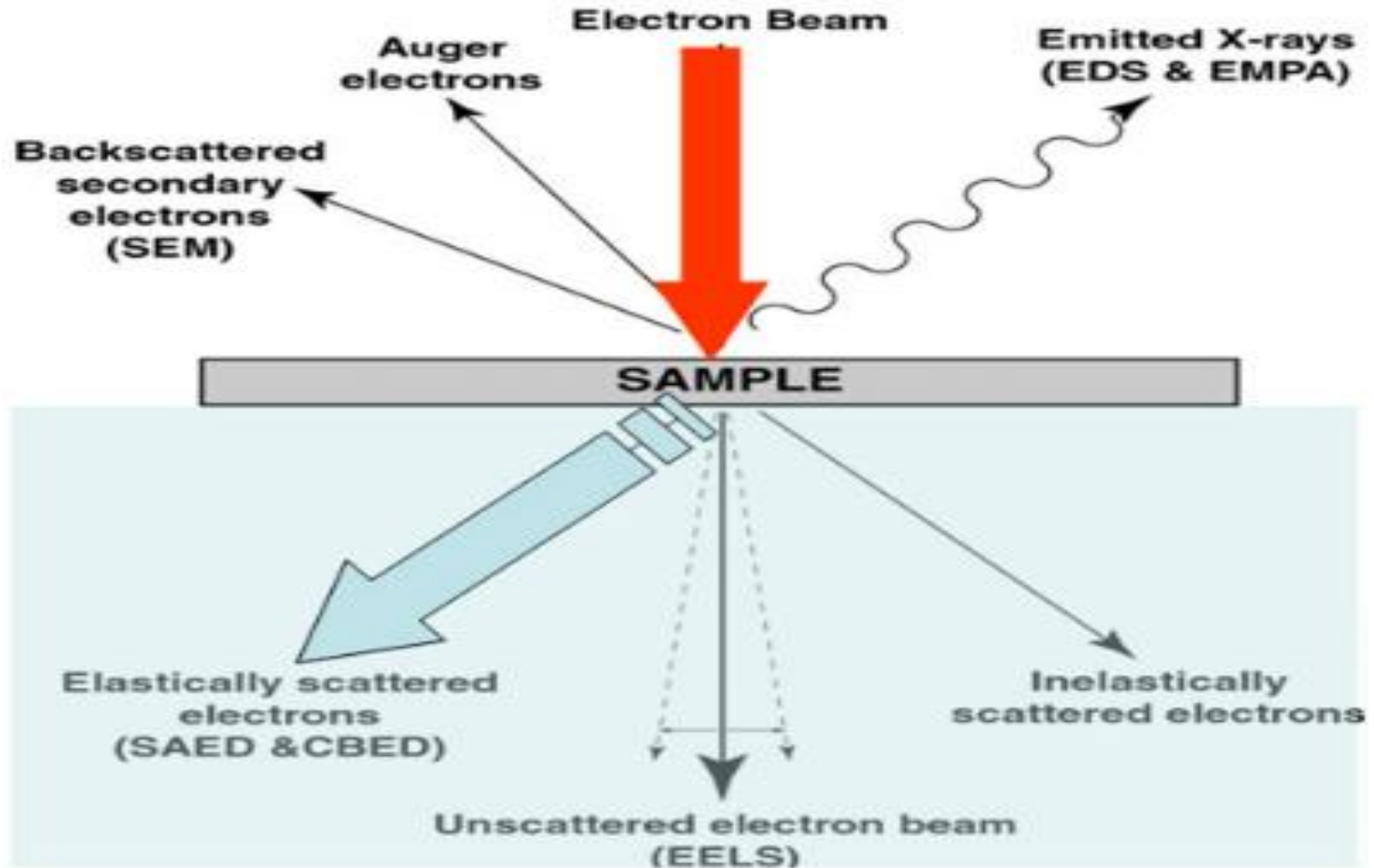


Microscopy History

- ▶ Anton van Leeuwenhoek(1961)- Anton van Leeuwenhoek is generally credited with bringing the microscope to the attention of biologists.



Electrons Matter Interaction



References (Contents)

- ▶ **Dr SANTOSH KARADE Slides (SlideShare.net)**
- ▶ **Wikipedia (For Images)**
- ▶ **Researchgate.net (SEM & TEM Difference)**

Disclosure

Only Use for Academic Purpose Only
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When we see the any objects?



Terms uses in Microscopy:

- ▶ **Magnification**: Degree of enlargement: No of times the length, breadth or diameter, of an object is multiplied.
- ▶ **RESOLUTION**: Ability to reveal closely adjacent structural details as separate and distinct
- ▶ **LIMIT OF RESOLUTION (LR)** : The min distance between two visible bodies at which they can be seen as separate and not in contact with each other
- ▶ **LR** = $(0.61 \times \text{lamda}) / \text{NA}$
lamda = Wavelength, **NA** = Num aperture

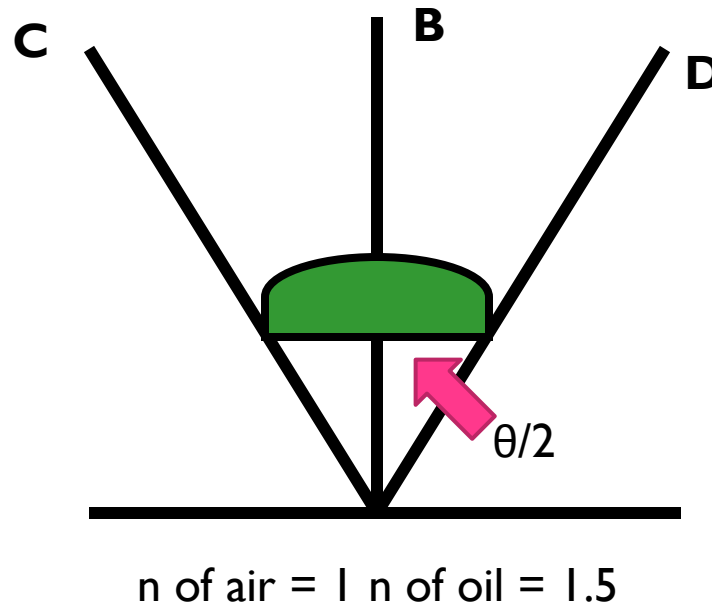


NUMERICAL APERTURE(NA)

- Ratio of diameter of lens to its focal length
- $NA = n \sin \theta/2$

n = Refractive index,

θ = Angle of aperture (CAD)



Types of Microscope

- ▶ Simple microscope
- ▶ Compound microscope
- ▶ Phase Contrast Microscope
- ▶ Dark Ground Microscope
- ▶ Fluorescent Microscope
- ▶ **Electron Microscope**..etc



General Comparison

Types of Microscope	Resolution Power
Compound Microscope	200 nanometers
Scanning Electron Microscope	10 nanometers
Transmission Electron Microscope	0.2 nanometers



ELECTRON MICROSCOPE

- ▶ Electron Microscopes uses a beam of highly energetic electrons to examine objects on a very fine scale. This examination brings the details about the observant.
- ▶ **Topography**
- ▶ **Morphology**
- ▶ **Composition**
- ▶ **Crystallographic Structure**



TYPES OF ELECTRON MICROSCOPE

- ▶ Scanning Electron Microscope (SEM)
- ▶ Transmission Electron Microscope (TEM)

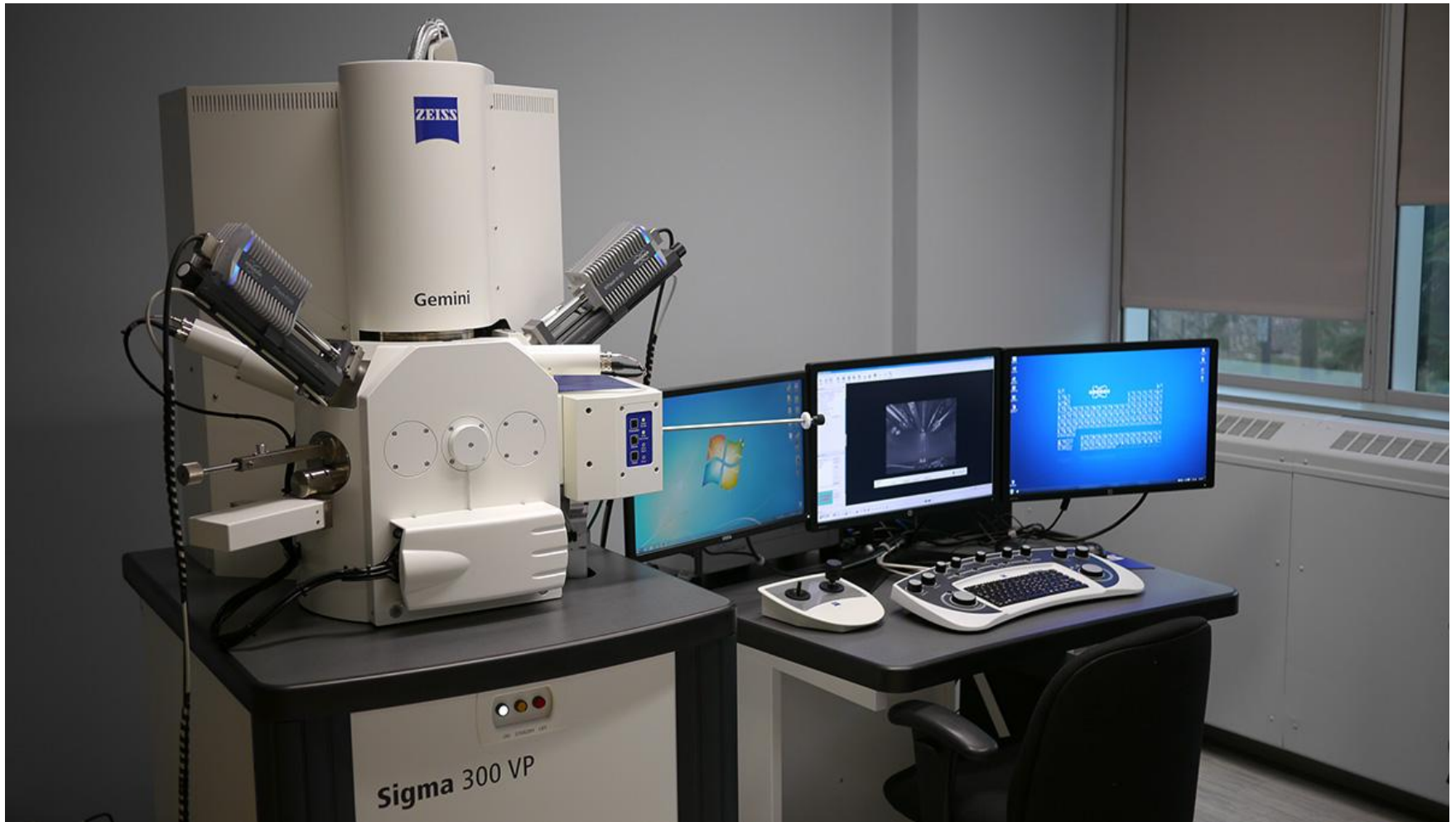


SCANNING ELECTRO MICROSCOPE

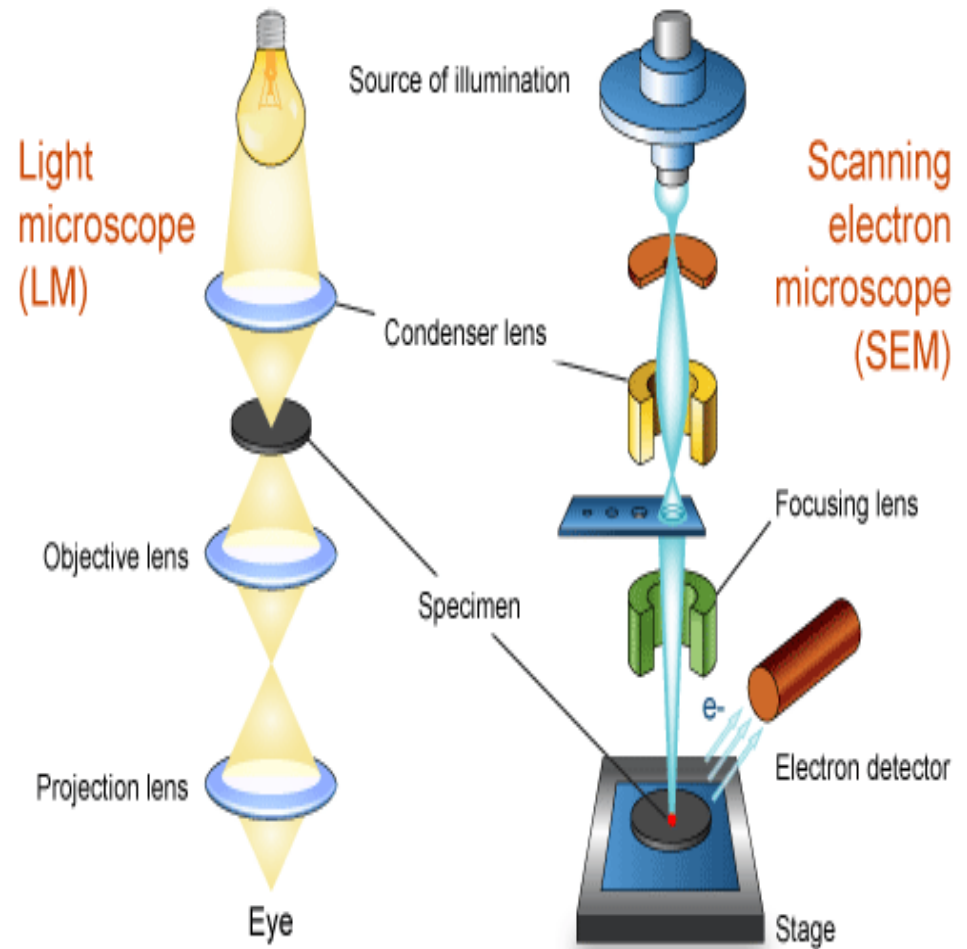
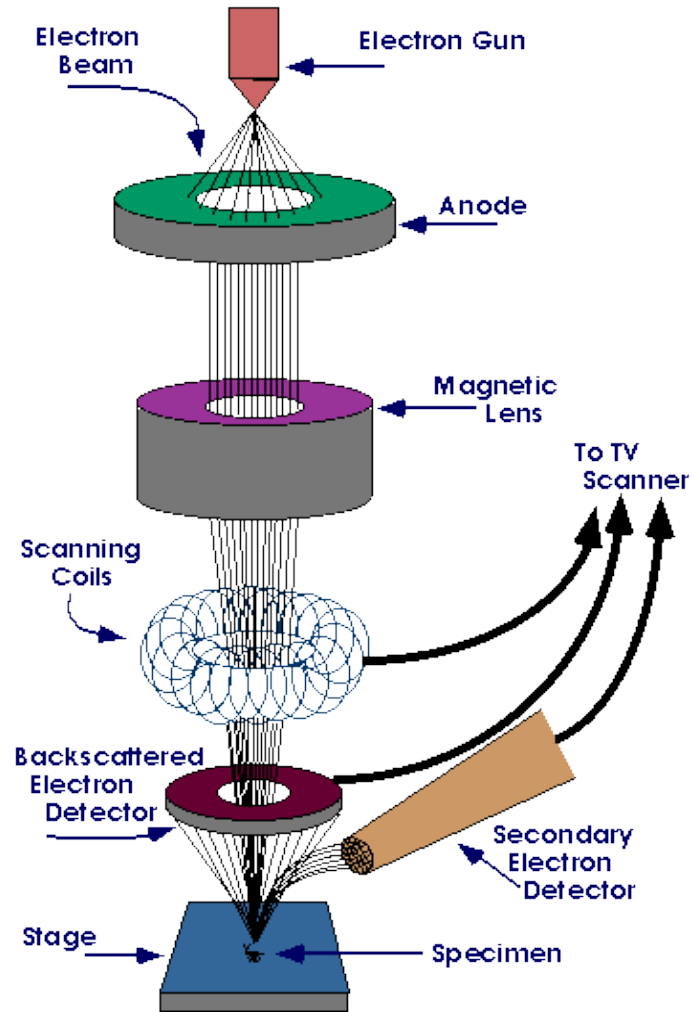
- SEM focuses on the sample's surface and its composition
- Scan a gold-plated specimen to give a 3-D view of the surface of an object which is black and white.
- Used to study surface features of materials, cells and viruses.
- Scanning Electron microscope has resolution 1000 times better than Light microscope.

SEM Microscope

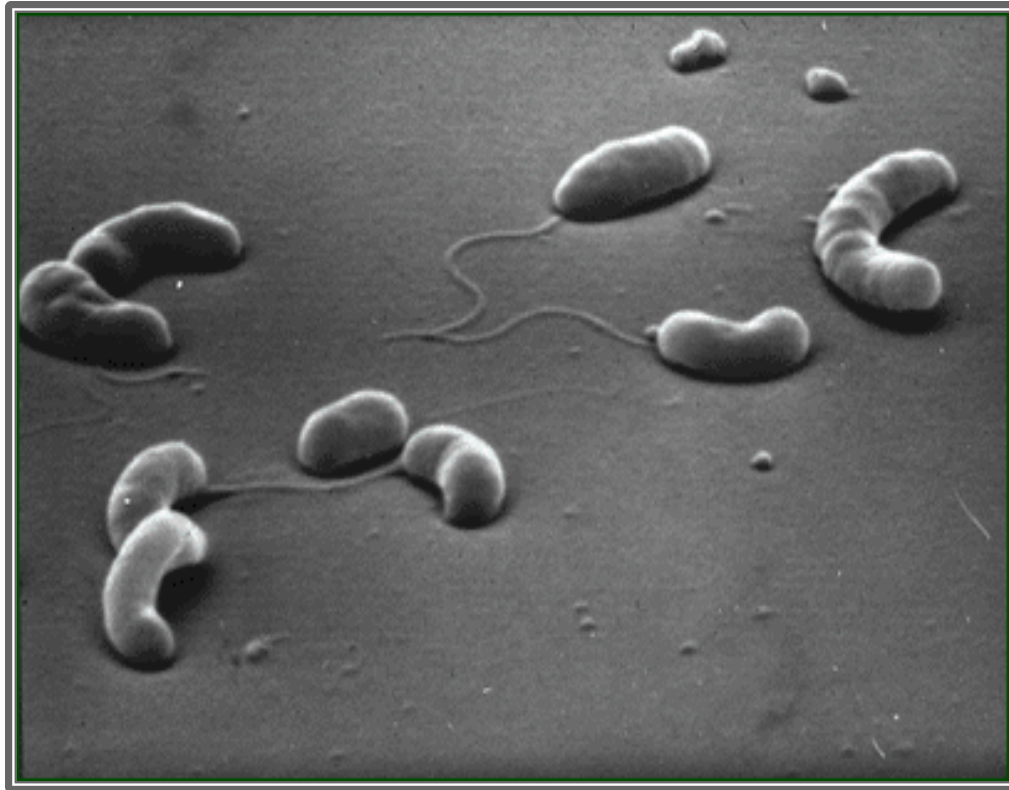
Image: University of Alberta



SEM Structure (Two Examples)



SEM Images (Micron Range)



Vibrio cholerae with polar Flagella

SEM Images (House Fly)



Image Courtesy: www.groundzeroweb.com



SEM Images

Bacteria on the surface of a human tongue

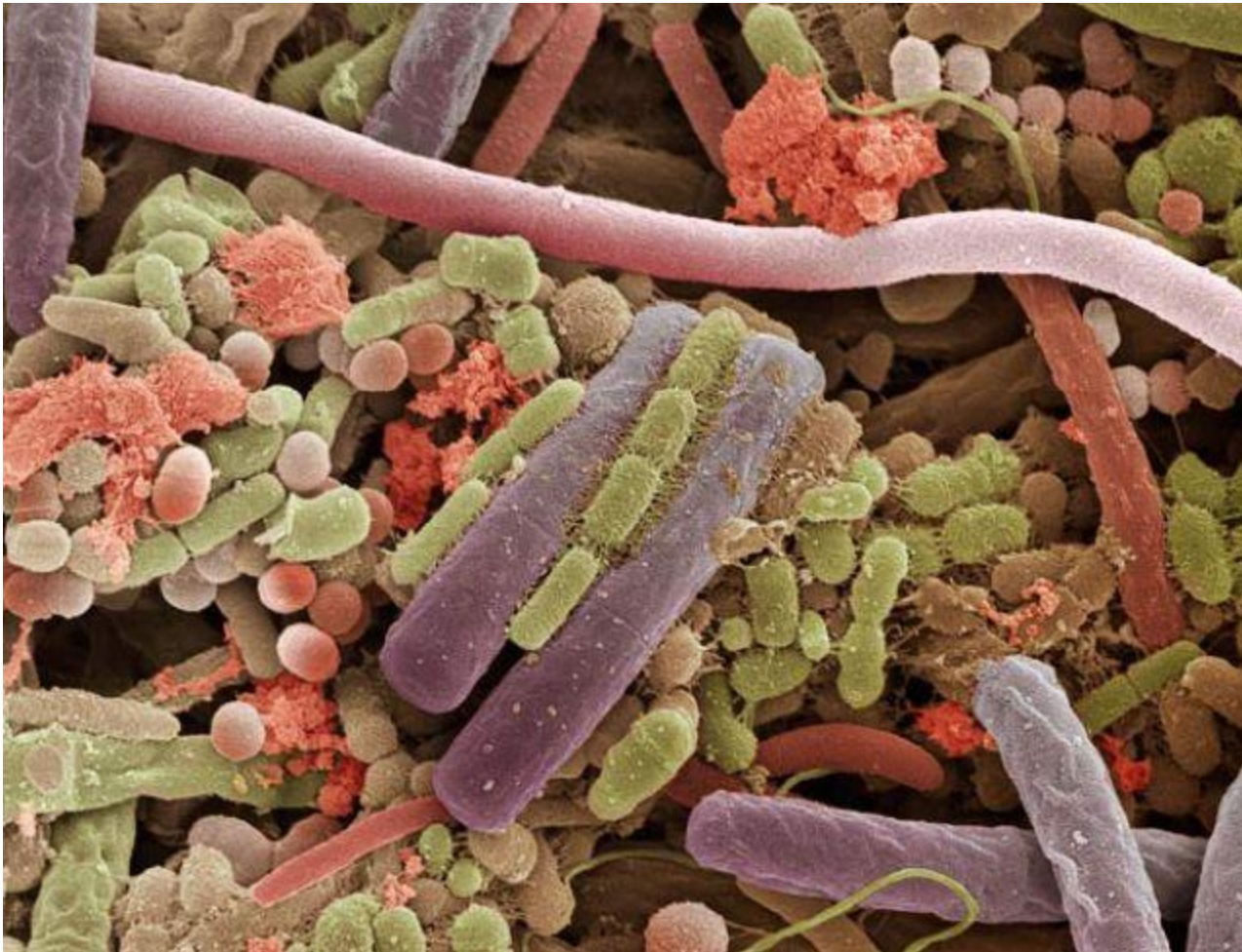


Image Courtesy:<http://izismile.com>

SEM Images

This is a platinum wire that has been milled to 50nm in diameter. It is to be used a gas sensor.

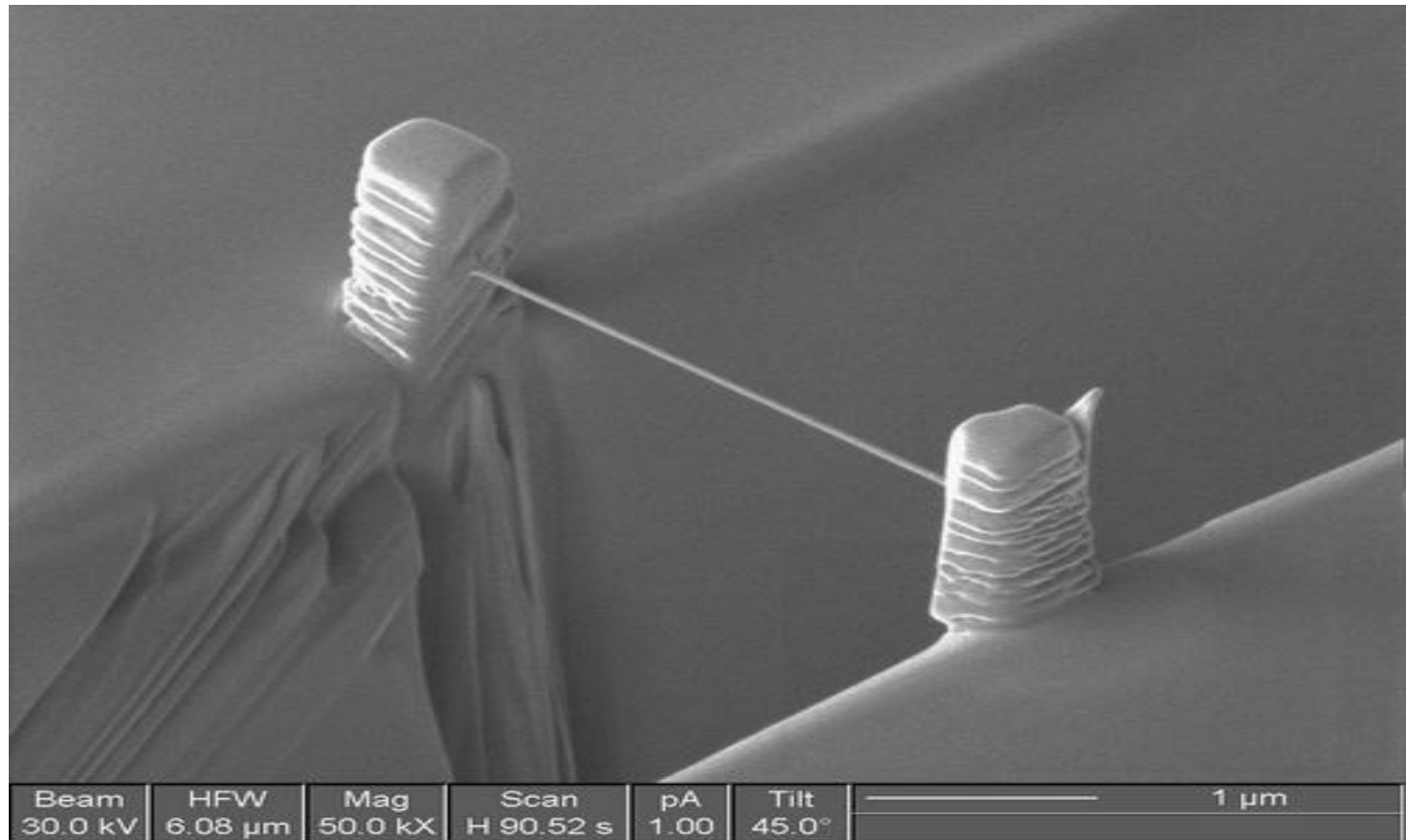


Image Courtesy: <http://www.onelargeprawn.co.za>

SEM Images

Human Eye



SEM Images

Ant Holding a Microchip

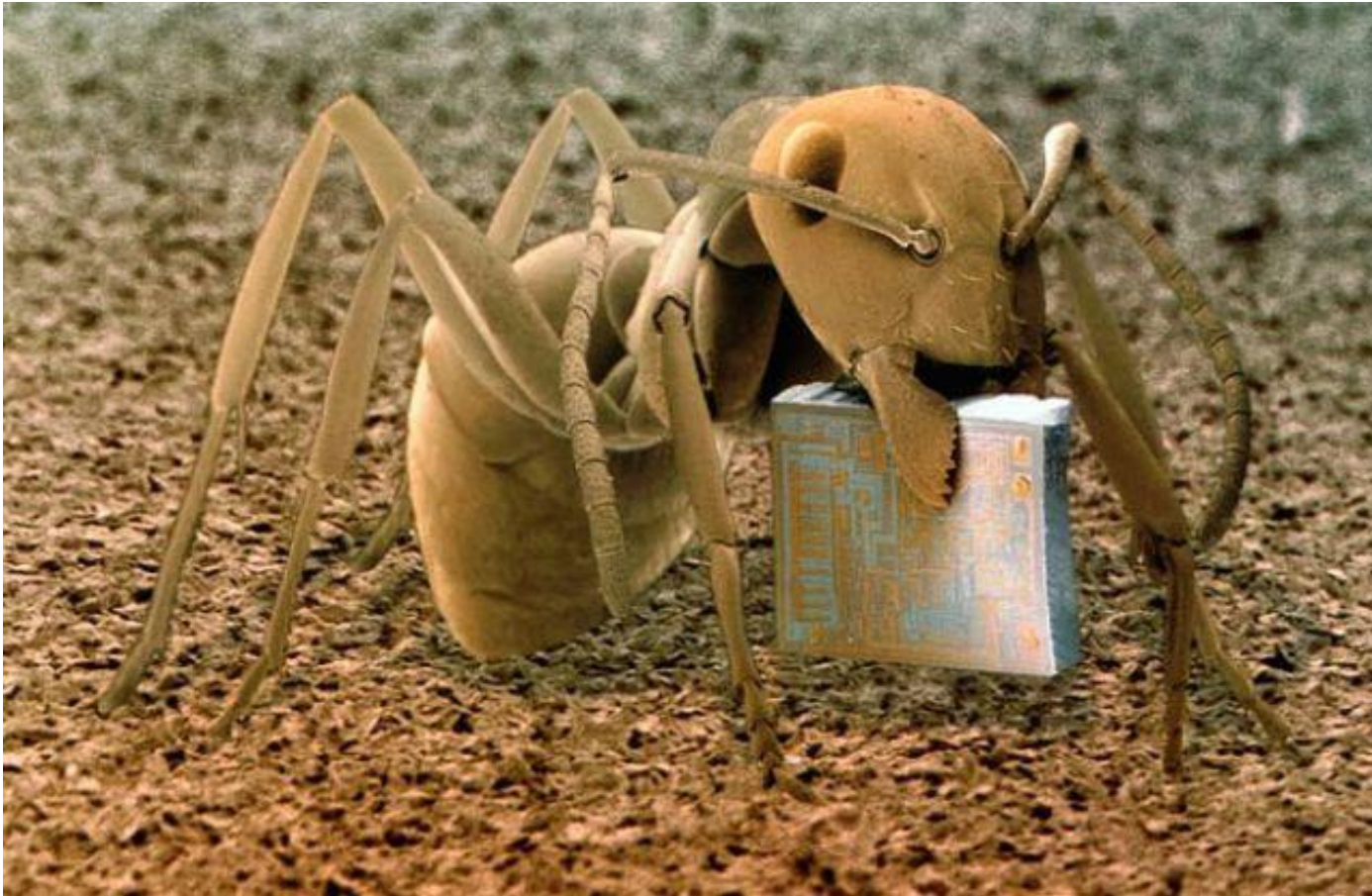


Image Courtesy:<http://izismile.com>

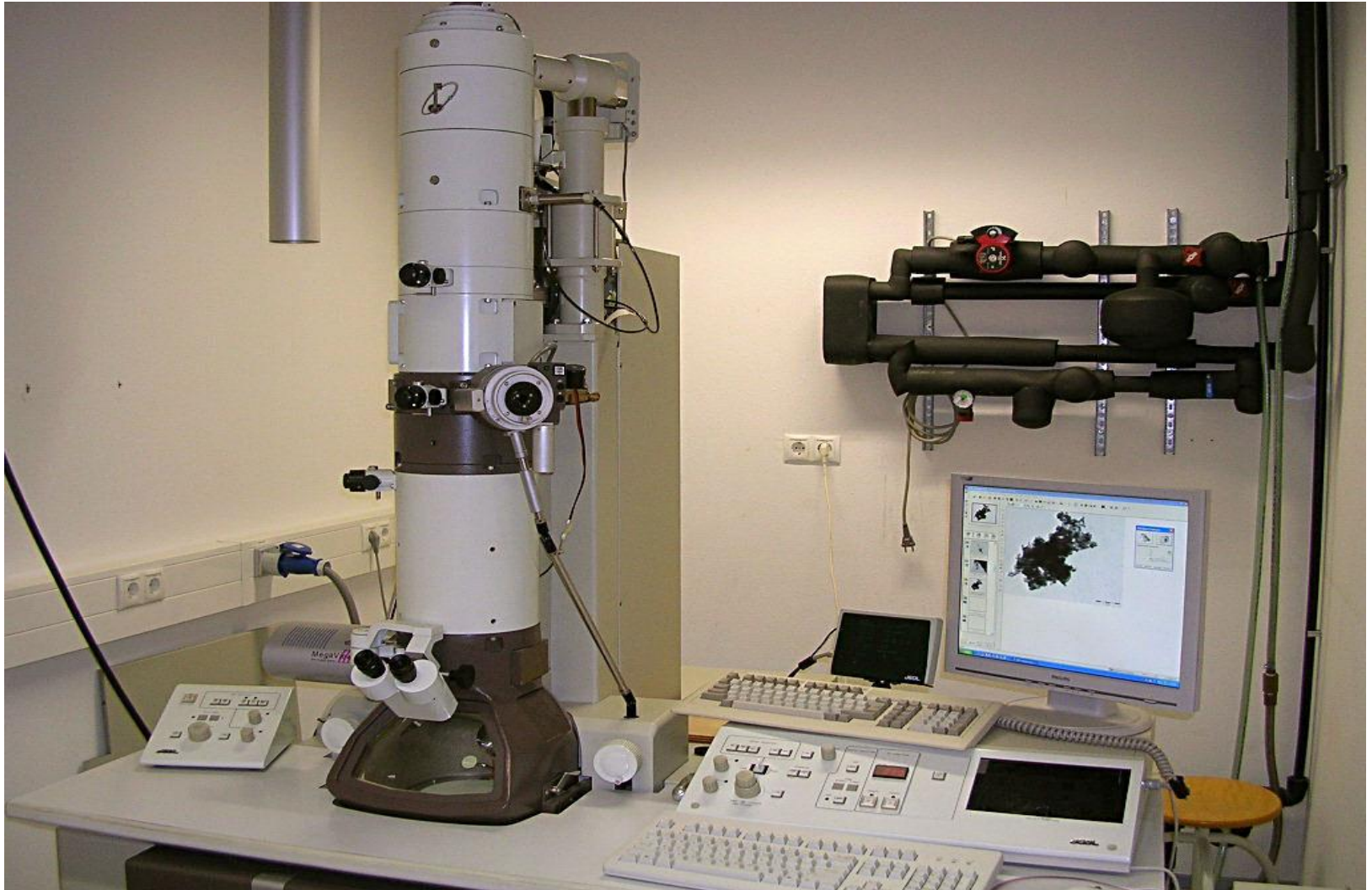


TRANSMISSION ELECTRON MICROSCOPE

(TEM)-STEM-Scanning TEM

- ▶ Stream of electrons is formed.
- ▶ Accelerated using a positive electrical potential
- ▶ Focused by metallic aperture and Electro magnets
- ▶ Interactions occur inside the irradiated sample which are detected and transformed into an image .
- ▶ *Scanning electron microscopy* allows for higher magnification and better resolution than standard light microscopy.
- ▶ Since the sample is bombarded with electrons rather than light, the level of detail in a smaller area is much greater than a light microscope

TEM Microscope



Diffraction:

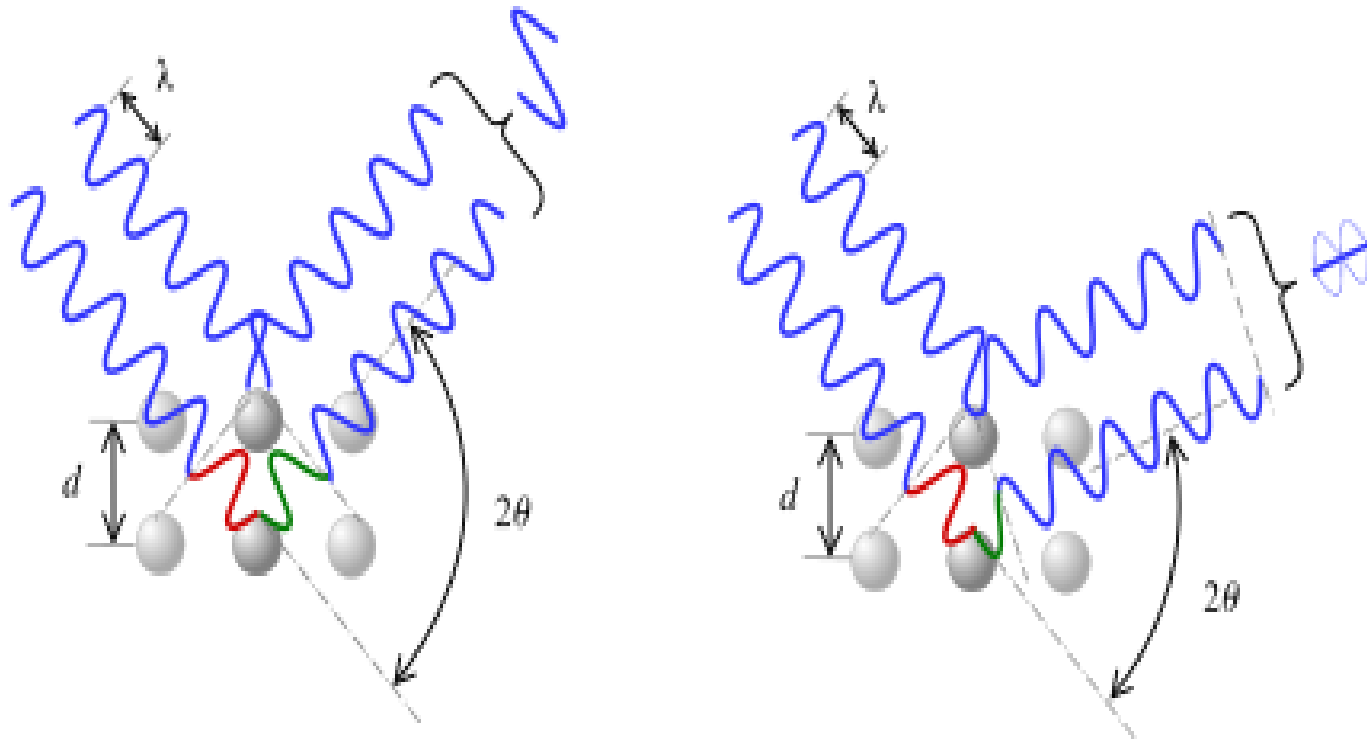


Image Courtesy: Wiki



TEM-Transmission Electron Microscope

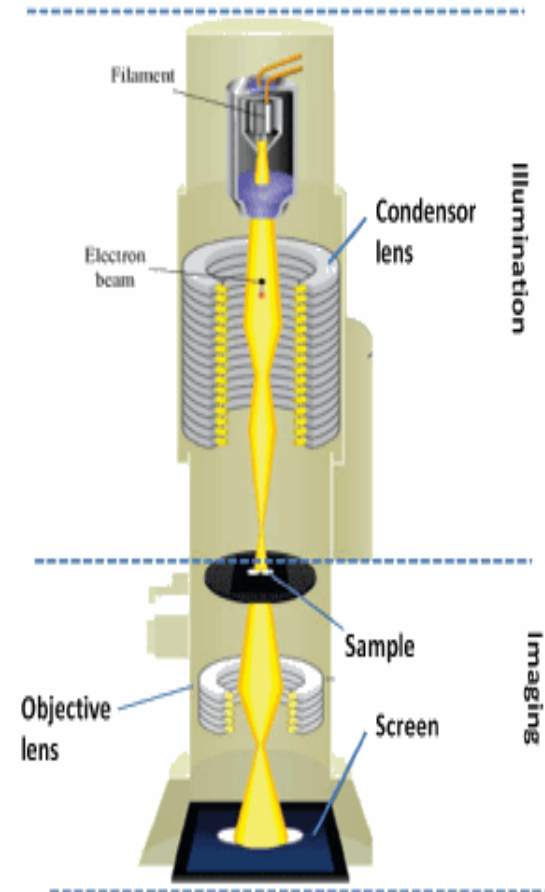
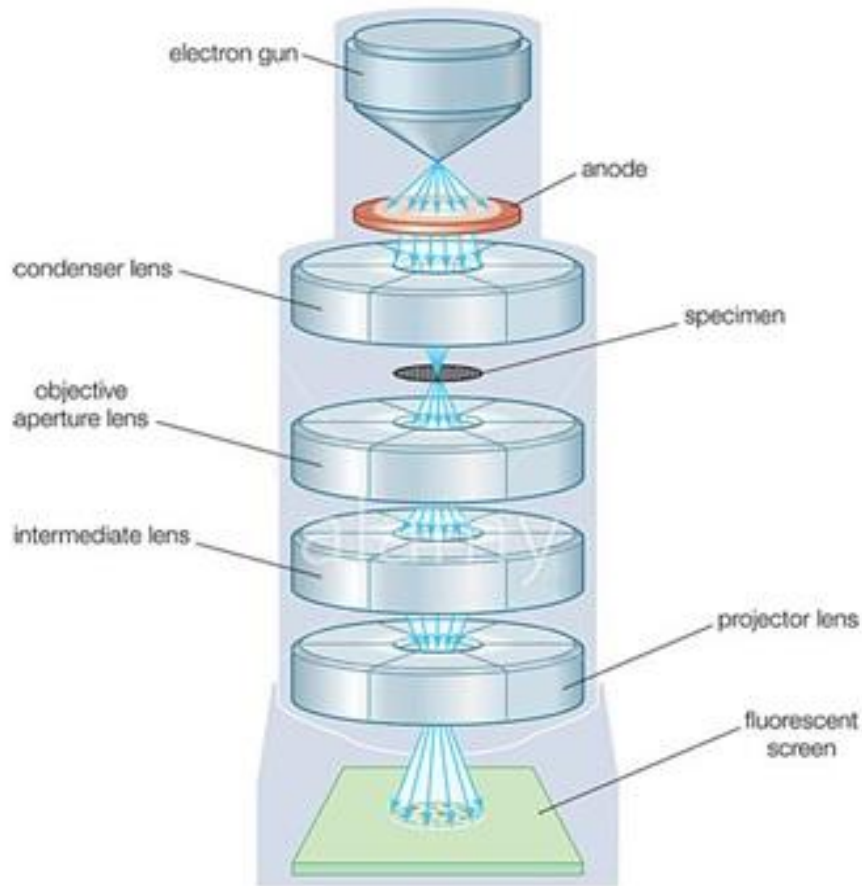
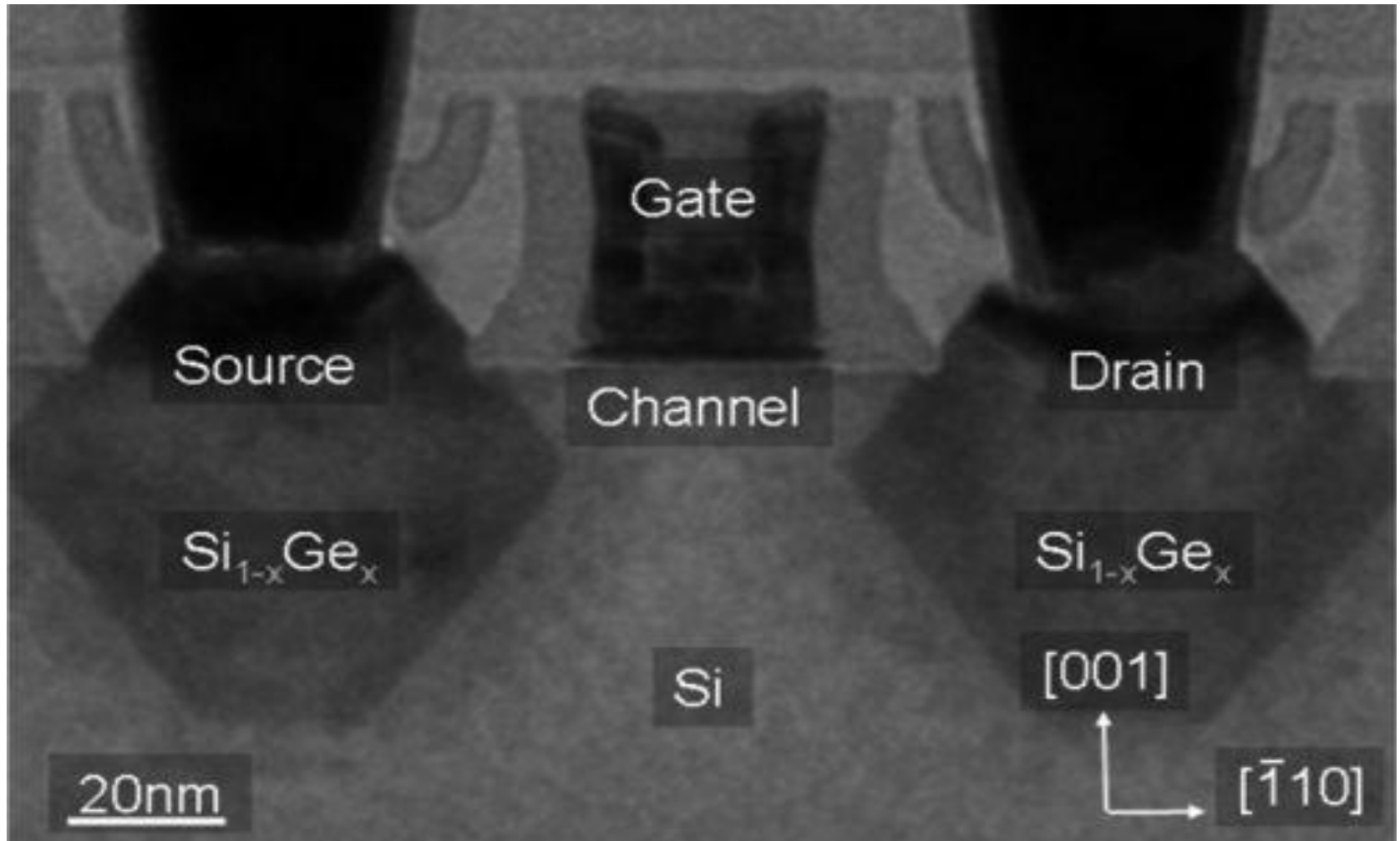


Image Source: Encyclopedia Britannica

TEM Images



TEM Images

A transmission electron microscope image of Apple A7 28nm NMOS transistors.



Image Courtesy: E Times of India

SEM vs. TEM

- ❑ SEM is based on scattered electrons while TEM is based on transmitted electrons.
 - ❑ SEM focuses on the sample's surface and its composition whereas TEM provides the details about internal composition. Therefore TEM can show many characteristics of the sample, such as morphology, crystallization, stress or even magnetic domains. On the other hand, SEM shows only the morphology of samples.
 - ❑ The sample in TEM has to be cut thinner whereas there is no such need with SEM sample.
 - ❑ TEM has much higher resolution than SEM.
 - ❑ SEM allows for large amount of sample to be analyzed at a time whereas with TEM only small amount of sample can be analyzed at a time.
-



SEM vs. TEM

- ❑ SEM is used for surfaces, powders, polished & etched microstructures, IC chips, chemical segregation whereas TEM is used for imaging of dislocations, tiny precipitates, grain boundaries and other defect structures in solids
- ❑ In TEM, pictures are shown on fluorescent screens whereas in SEM, picture is shown on monitor.
- ❑ SEM also provides a 3-dimensional image while TEM provides a 2-dimensional picture.
- ❑ TEM requires extensive sample preparation. The thickness of the specimens to be examined under TEM should be less than 100nm.



Advanced MICROSCOPES

❑ **SCANNING PROBE MICROSCOPE** -Class of Microscope that measures surface features by moving a sharp probe over object surface. Used to visualize atoms and molecules in more distinctly.

❑ **Scanning Tunneling Microscope (STM)**

❑ **Atomic Force Microscope (AFM)**

TAHNK YOU 4 UR Kind Attention..!

You all are awesome



kalyan.achariya@gmail.com

kalyan5.blogspot.in

