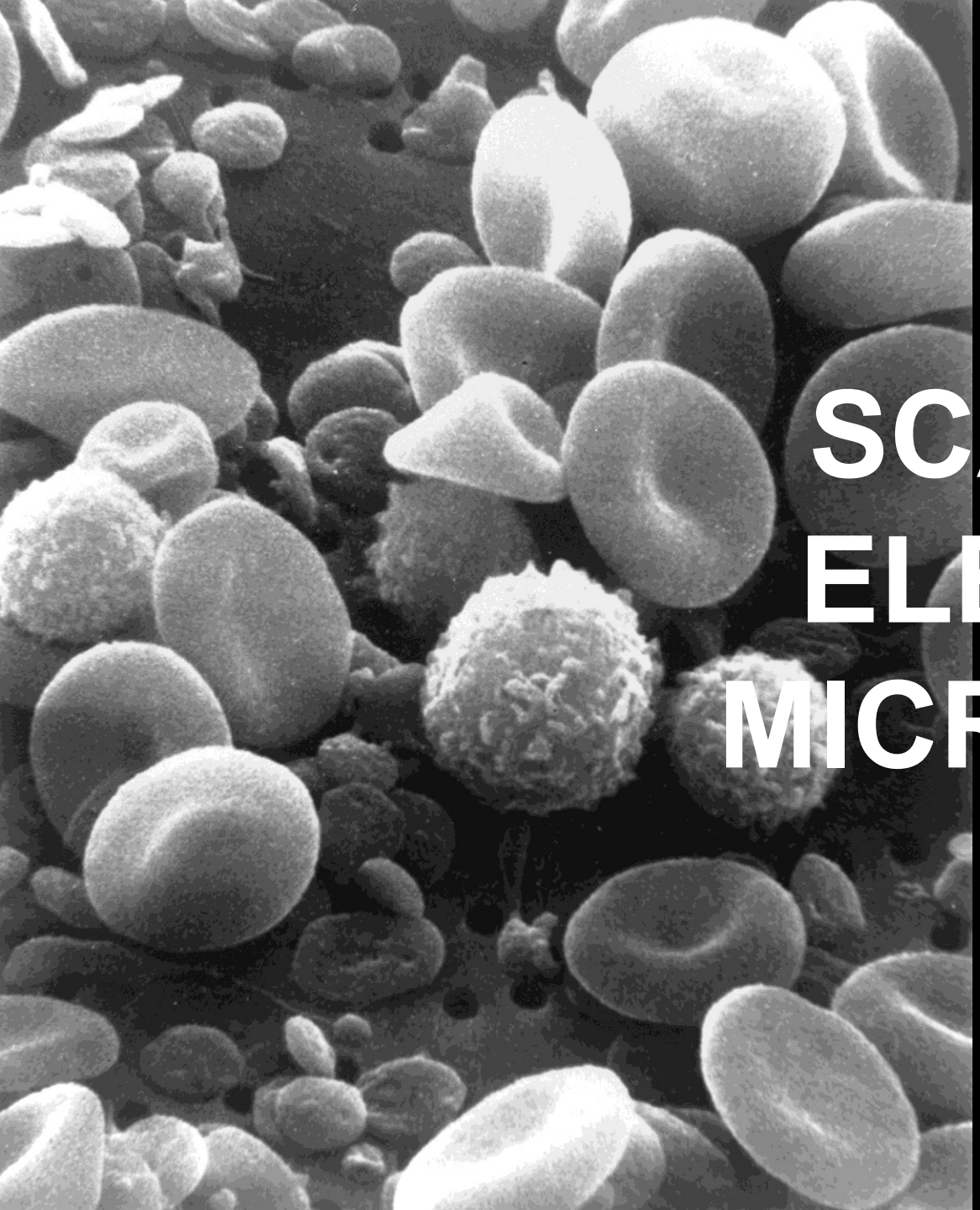

21.05.2010
Hacettepe University

SCANNING ELECTRON MICROSCOPE

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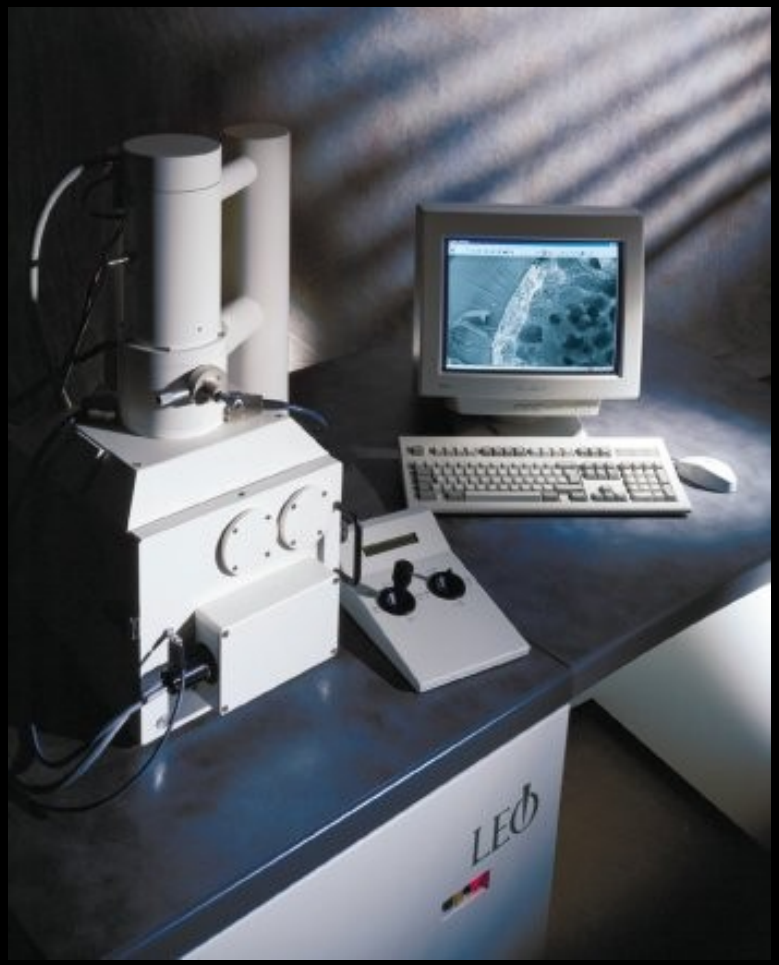
OUTLINE

- Definition of scanning electron microscope
- History
- Applications of SEM
- Components of the instrument.
- Working principle of the SEM
- Advantages & Disadvantages
- Conclusion

What is SEM?



- SEM=Scanning Electron Microscope
- It is a type of electron microscope
- The SEM is a microscope that uses electrons instead of light to form an image

HISTORY

- The first SEM image was obtained by Max Knoll, who in 1935 obtained an image of **silicon steel** showing electron channeling contrast
- The SEM was further developed by Professor Sir Charles Outley and his postgraduate student Gary Stewart and was first marketed in 1965 by the Cambridge Instrument Company as the “Stereoscan”.

Applications of 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.

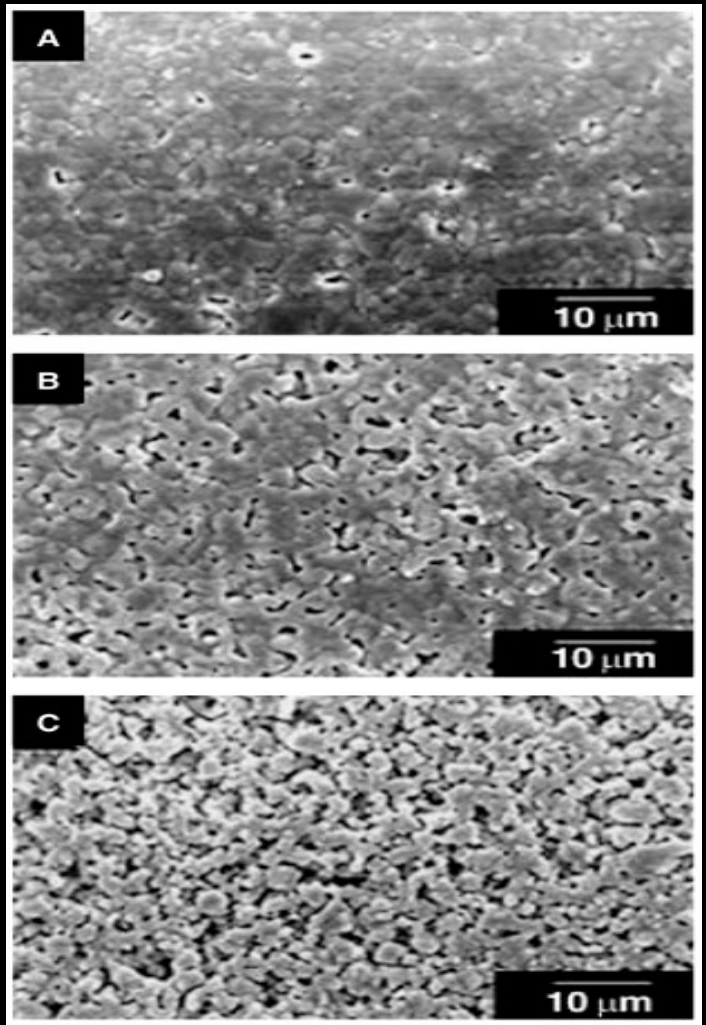
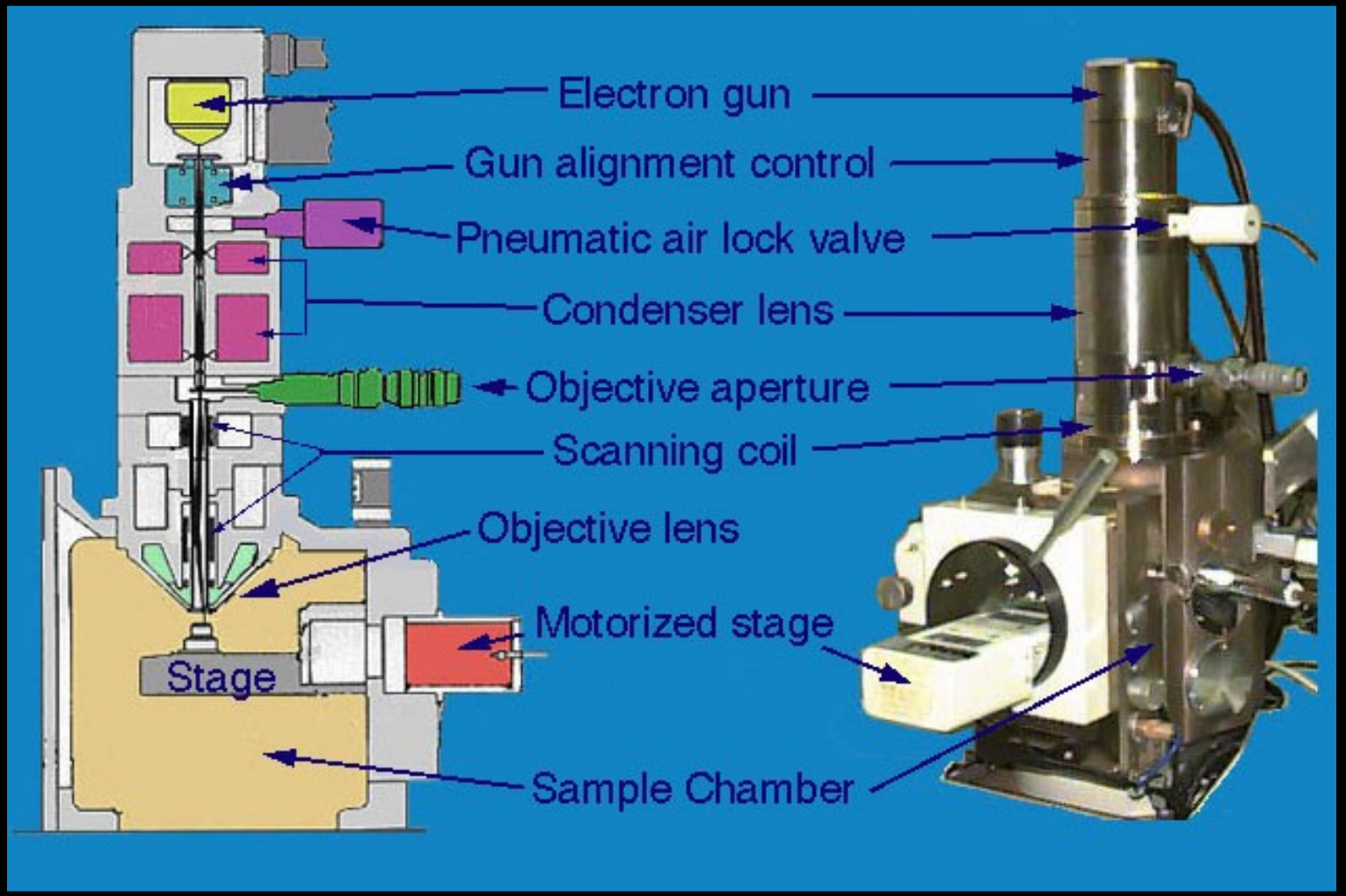


FIGURE 1 - Scanning electron microscopy (SEM) of the hydroxyapatite (HA) surfaces. (A) HA5 (5% of microporosity); (B) HA15 (15% of microporosity) and (C) HA30 (30% of microporosity).

Applications of SEM

- **Crystallographic Information:** How the atoms are arranged in the object; direct relation between these arrangements and material properties.
- **Composition:** The elements and compounds that the object is composed of and the relative amounts of them; direct relationship between composition and material properties.

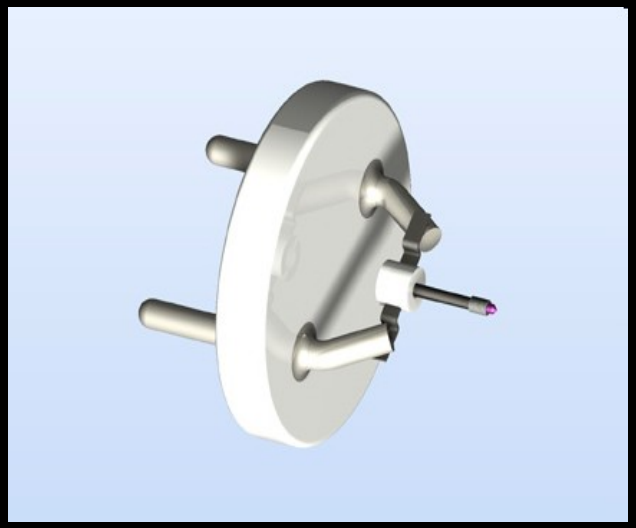
Main Parts of SEM

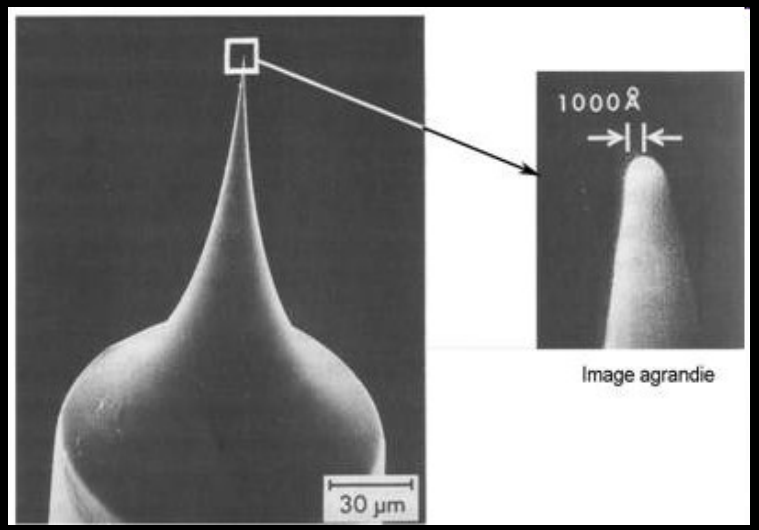


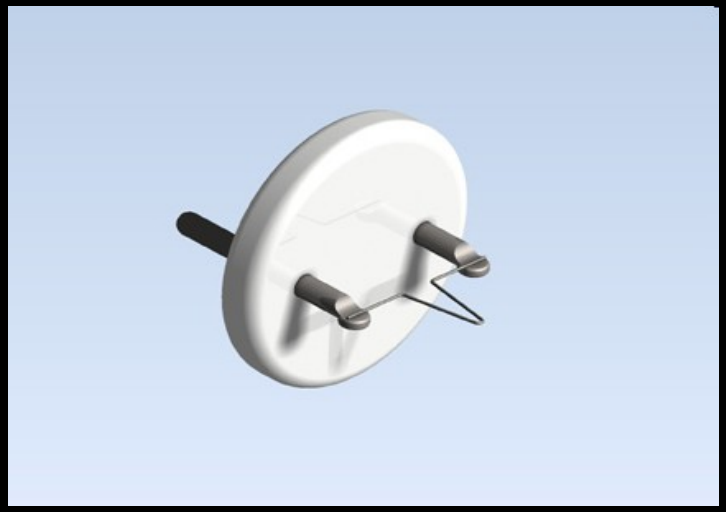
Electron Guns

- We want many electrons per time unit per area (high current density) and as small electron spot as possible
- Traditional guns: thermionic electron gun (electrons are emitted when a solid is heated)
- Modern: field emission guns (FEG) (cold guns, a strong electric field is used to extract electrons)

Electron Guns







Detectors

Backscattered electron detector:
(Solid-State Detector)

Secondary electron detector:
(Everhart-Thornley)

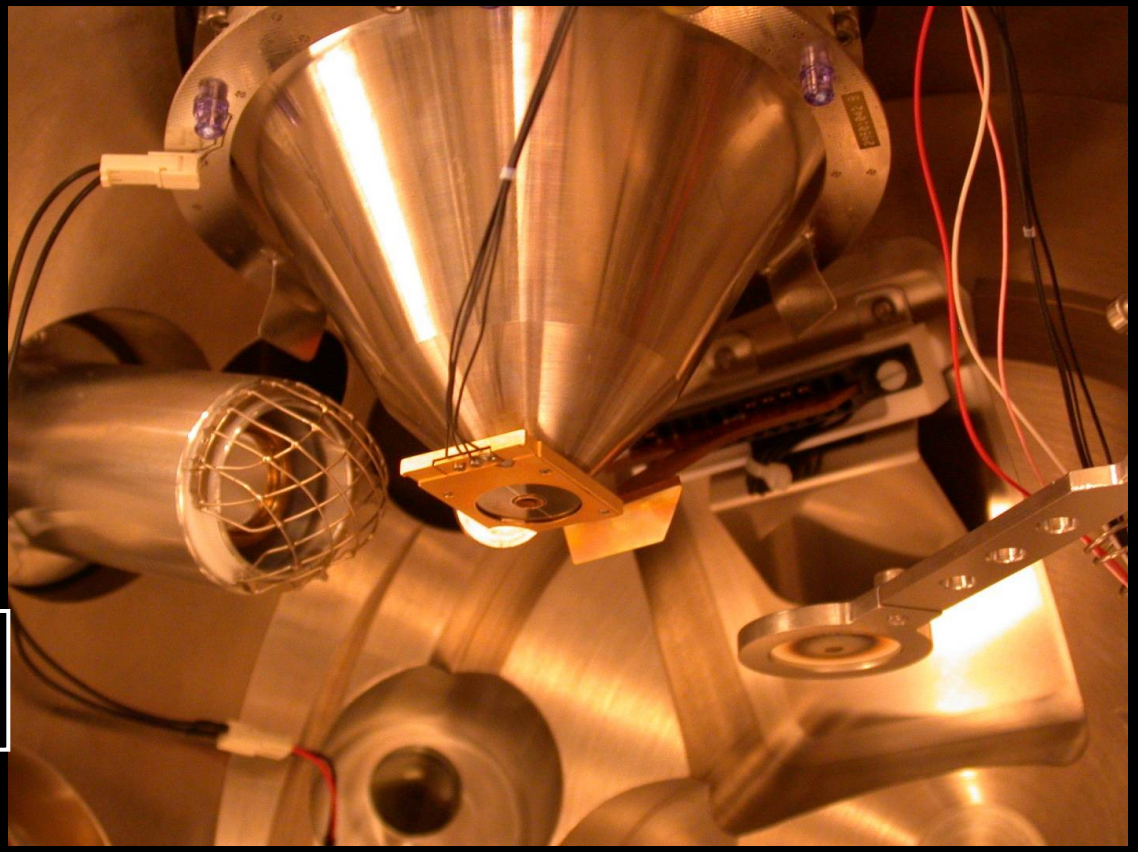


Image: Anders W. B. Skilbred, UiO

Our Traditional Detectors

- Secondary electrons: Everhart-Thornley Detector
- Backscattered electrons: Solid State Detector
- X-rays: Energy dispersive spectrometer (EDS)

Why do we need Vacuum?

- Chemical (corrosion!!) and thermal stability is necessary for a well-functioning filament (gun pressure)

- The signal electrons must travel from the sample to the detector (chamber pressure)

Sample Preparation

- All water must be removed from the sample
- All samples must also be trimmed to an apropriate size
- Metals no preparation
- Non-metalics cover the sample with a thin layer of a conductive material

Sputter Coater

•The sputter coater is used to coat nonmetallic samples (bugs, plants, human hair, etc.) with a thin layer of gold.

•This makes them conductive, and ready to be viewed by the SEM. If the samples are metallic, they can simply be mounted and placed in the SEM.

Advantages

- High resolution of images
- A superior level of magnification
- A large dept of field
- Uses electromagnets as an alternative to lenses
- 3D data of sample can be measured
- Preparation of sample is relatively easy

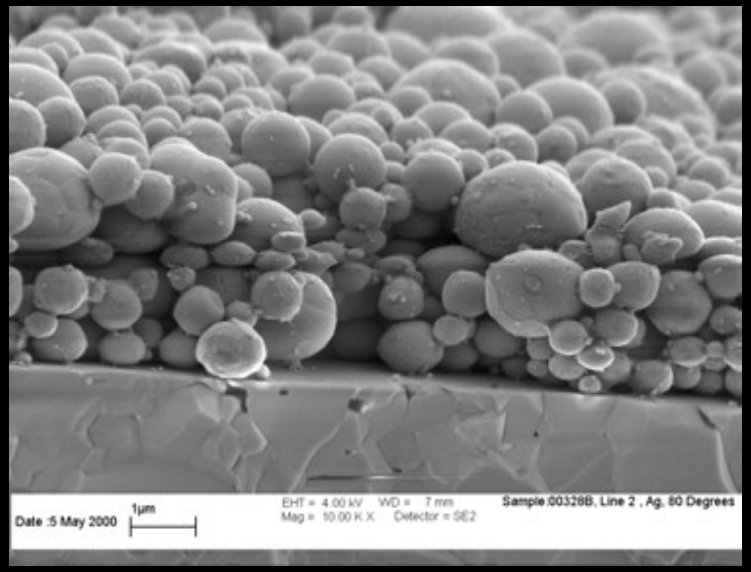
Disadvantages

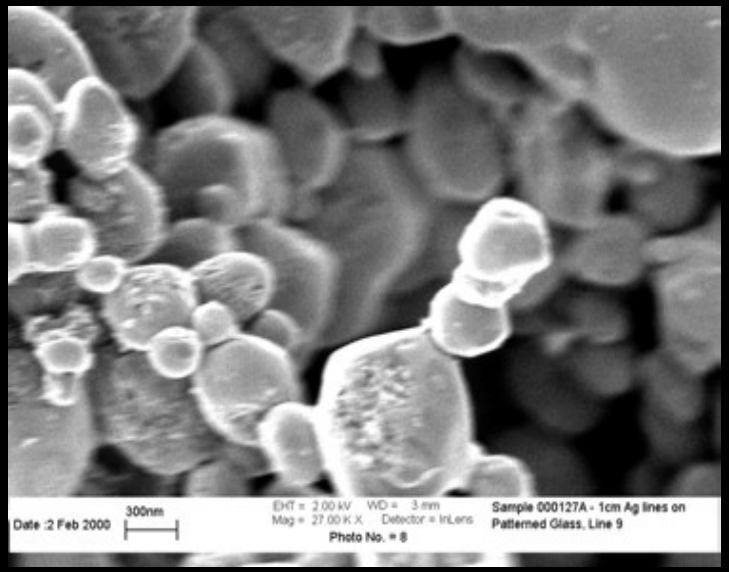
- **Costly to purchase and maintain**
- **Sample have to be viewed in vacuum**
- **Non-conductive materials need coating**
- **Sensitive to vibration and external magnetic fields**
- **Sensitive to electrical supply**
- **SEMs are radiation-generating devices; so users need developing a 'SEM safety plan'**

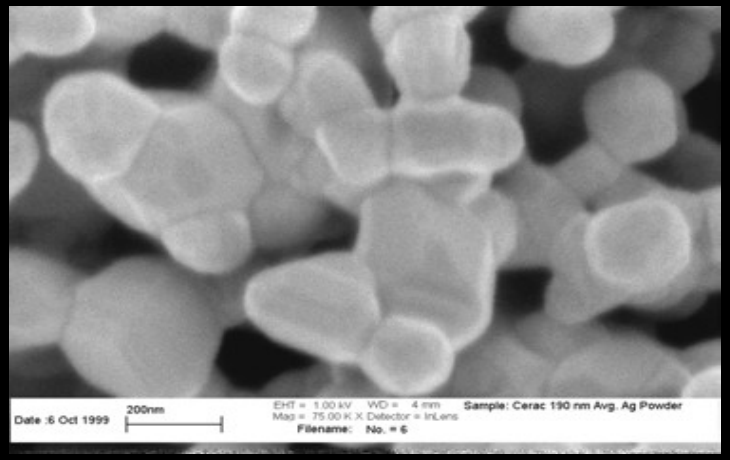
Summary

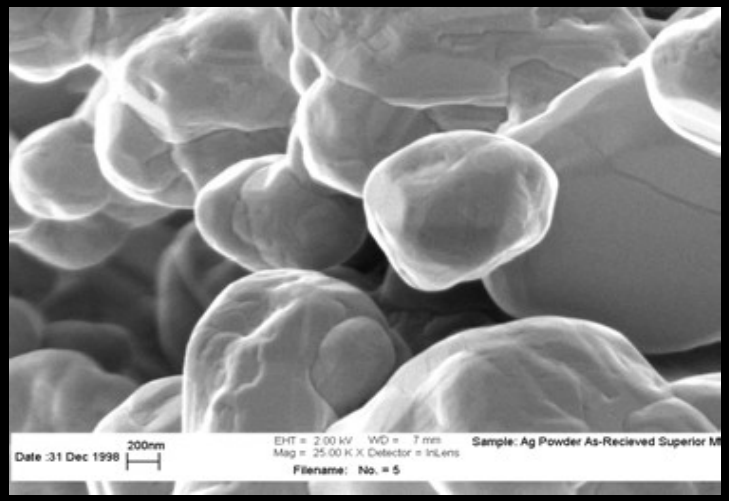
- The scanning electron microscope is a versatile instrument that can be used for many purposes and can be equipped with various accessories
- An electron probe is scanned across the surface of the sample and detectors interpret the signal as a function of time
- A resolution of 1 – 2 nm can be obtained when operated in a high resolution setup
- The introduction of ESEM and the field emission gun have simplified the imaging of challenging samples

Sem Application Fotos

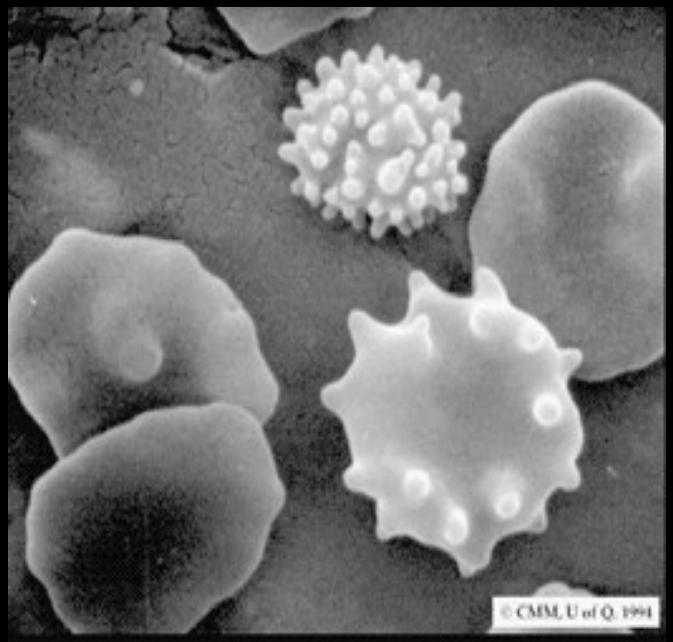




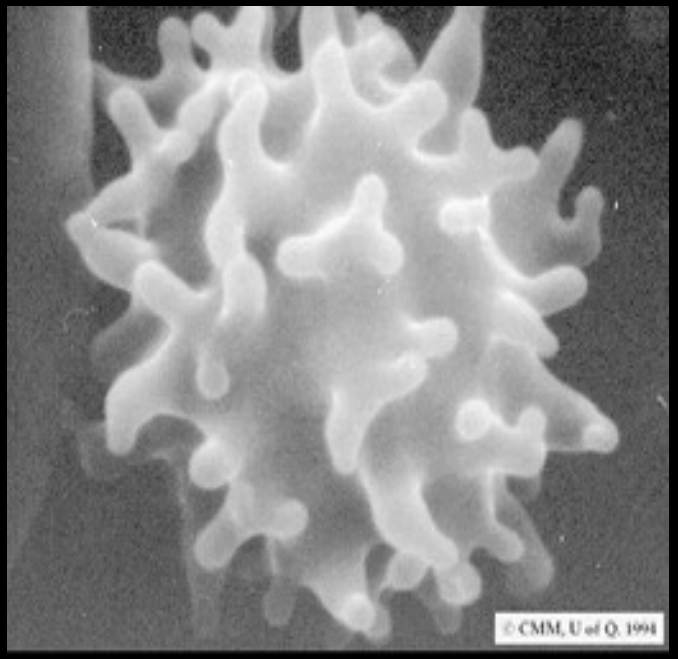




Sem Application Fotos



Blood Cells



A Lymphocyte
(White Blood Cell)

Thanks For Your Attention ☺