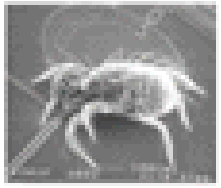
Overview

- **Microscope Optik v.s SEM**
- **Scanning Electron Microscopy (SEM)**
  - Pengenalan SEM;
  - Interaksi Berkas elektron-Materi
  - Preparasi Sample
  - Kegunaan/Kelebihan SEM
  - Beberapa contoh SEM image bentonit

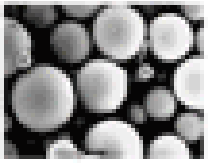
The Scale of Things – Nanometers and More

Things Natural



Dust mite
200 µm

Ant
~ 5 mm



Fly ash
~ 10-20 µm

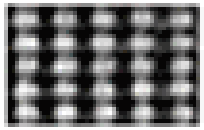
Human hair
~ 60-120 µm wide

Red blood cells
(~7-8 µm)

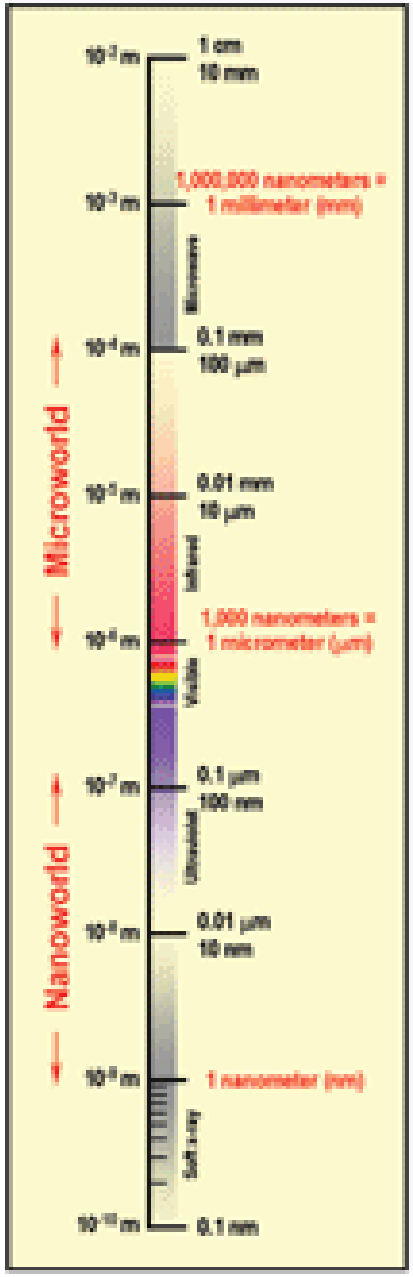
~10 nm diameter

ATP synthase

DNA
~2-1/2 nm diameter

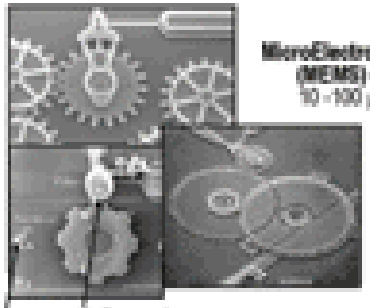


Atoms of silicon
spacing 0.078 nm



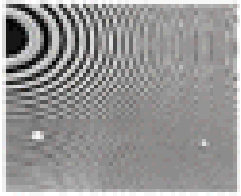
Things Manmade

Head of a pin
1-2 mm

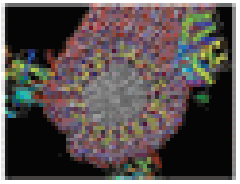


MicroElectroMechanical (MEMS) devices
10 - 100 µm wide

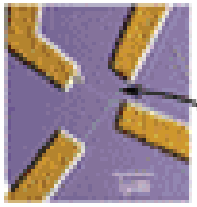
Pollen grain
Red blood cells



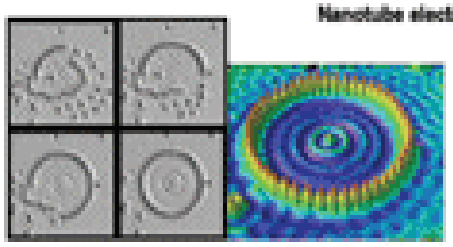
Zone plate x-ray "lens"
Outer ring spacing ~35 nm



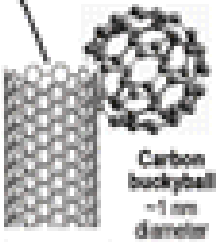
Self-assembled, Nature-inspired structure
Many 10s of nm



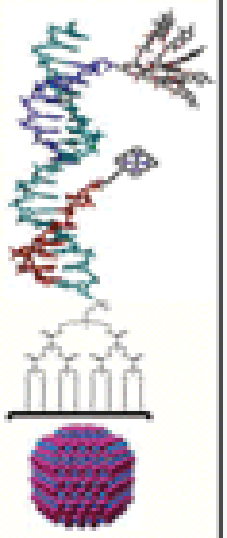
Nanotube electrode



Quantum corral of 48 iron atoms on copper surface positioned one at a time with an STM tip
Corral diameter 14 nm

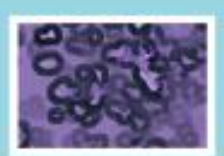


The Challenge



Fabricate and combine nanoscale building blocks to make useful devices, e.g., a photosynthetic reaction center with integral semiconductor storage.

Name	Symbol	Value	Equivalence	Illustration
terametre	Tm	10^{12}	1 terametre = 1000 000 000 000 metres = 1 trillion metres	 One light-hour (the distance travelled by light in one hour) is about 1079 million km or 1.08 Tm
gigametre	Gm	10^{9}	1 gigametre = 1000 000 000 metres = 1 billion metres	 The diameter of the Sun is about 1390 000 km or 1.39 Gm
megametre	Mm	10^{6}	1 megametre = 1000 000 metres = 1 million metres	 Approximate distance from Amsterdam (NL) to Bordeaux (FR)
kilometre	km	10^{3}	1 kilometre = 1000 metres = 1 thousand metres	 Angel Falls in Venezuela, the highest waterfalls in the world at a height of about 980 m
hectometre	hm	10^{2}	1 hectometre = 100 metres = 1 hundred metres	 Length of a football field
decametre	dam	10	1 decametre = 10 metres = ten metres	 Length of an orca (killer whale)
metre	m	1		 Length of a royal python

Name	Symbol	Value	Equivalence	Illustration
decimetre	dm	10^{-1}	1 decimetre = 0.1 metre = 1 tenth of a metre	 Length of a white mouse
centimetre	cm	10^{-2}	1 centimetre = 0.01 metre = 1 hundredth of a meter	 Width of a finger nail
millimetre	mm	10^{-3}	1 millimetre = 0.001 metre = 1 thousandth of a metre	 Pet flea
micrometre (or micron)	µm	10^{-6}	1 micrometre = 0.000 001 metre = 1 millionth of a metre	 Bacteria
nanometre	nm	10^{-9}	1 nanometre = 0.000 000 001 metre = 1 billionth of a metre	 Buckyball (carbon 60 molecule) or 100 000 times smaller than the width of a human hair
picometre	pm	10^{-12}	1 picometre = 0.000 000 000 001 metre = 1 trillionth of a metre	 Atom diameters are in the range from 30 to 600 pm

Microscope Optics v.s SEM

- Pemilihan Mikroscope Optik atau SEM/TEM sangat bergantung pada keperluan
- Untuk mengamati objek dengan ukuran mikron dapat digunakan M-Optik
- Untuk objek dengan skala sub micron (nm) dapat digunakan SEM-TEM

Microscope Optics v.s SEM

- Dapat dilengkapi dengan pemanas dan sensor temperature

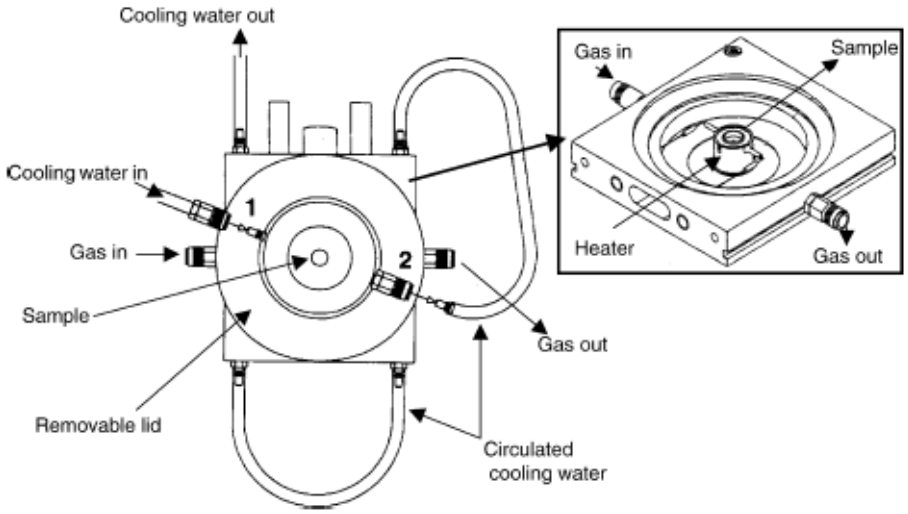


Fig. 1. Schematic figure of in situ reactor cell for the microscope observation.

Contoh Penggunaan Mikroskop Optik;

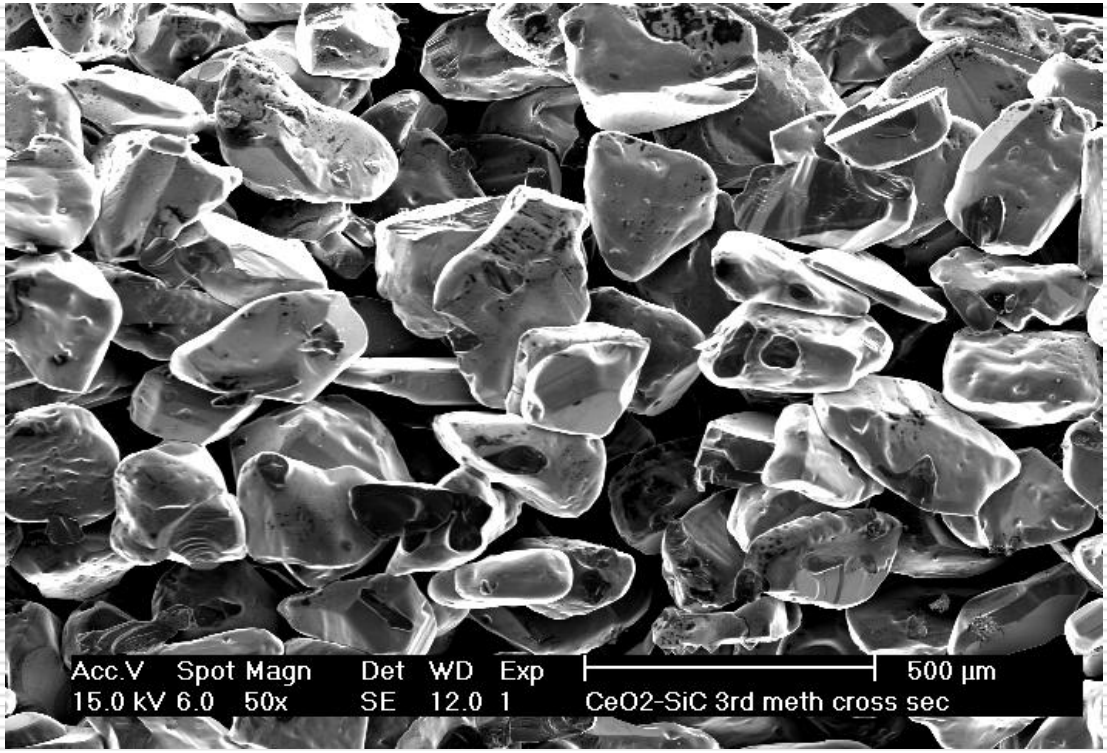
- Mobilitas Material pada Temp Sintering

Pengantar: SEM

- Contoh-contoh image SEM;
  Sample: Ceramic membrane
  Ceramic foam

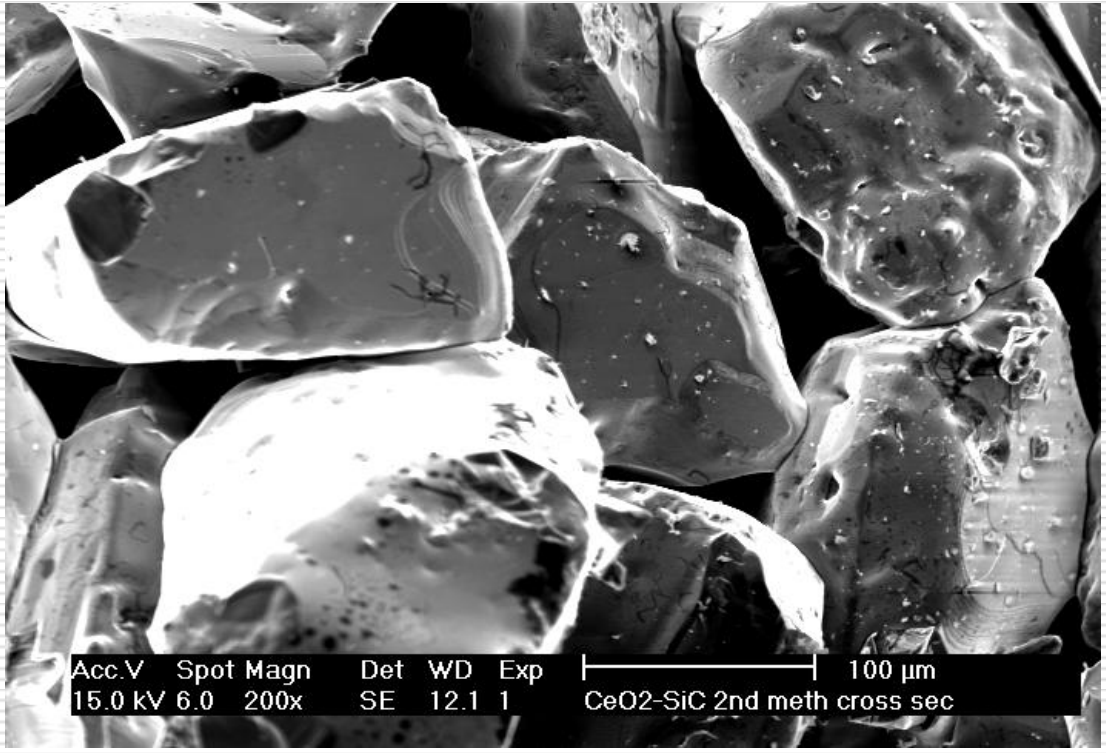
- Prinsip kerja

Pengantar: SEM



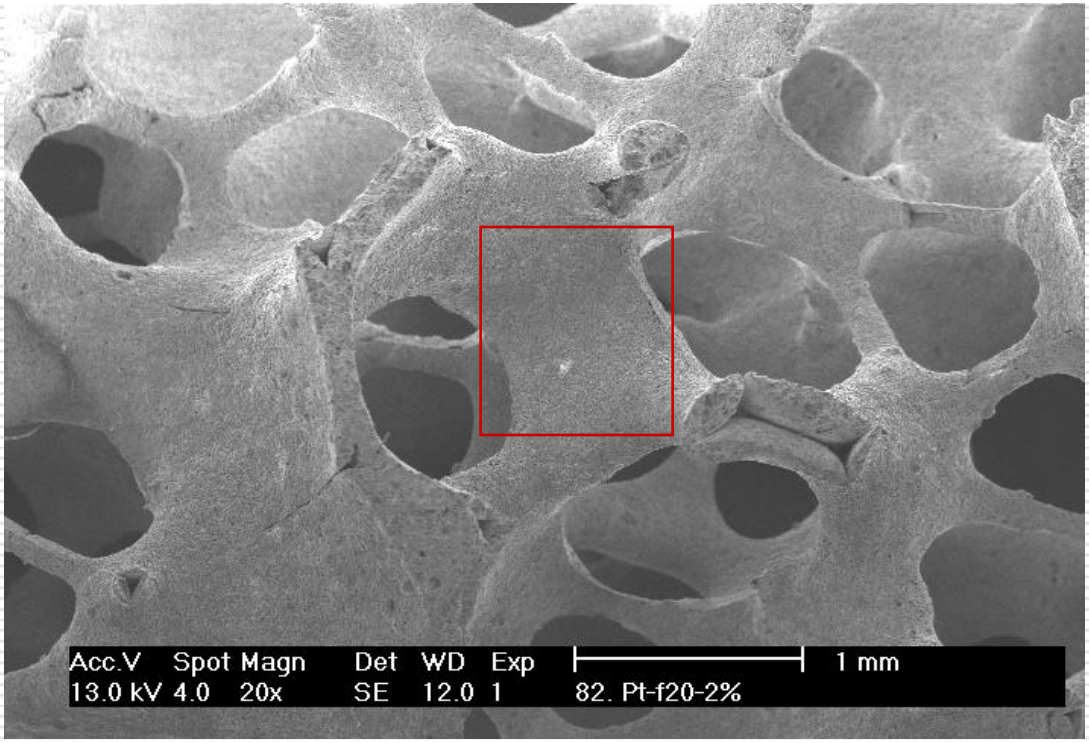
- Membrane SiC
- Perbesaran 50x

Pengantar: SEM



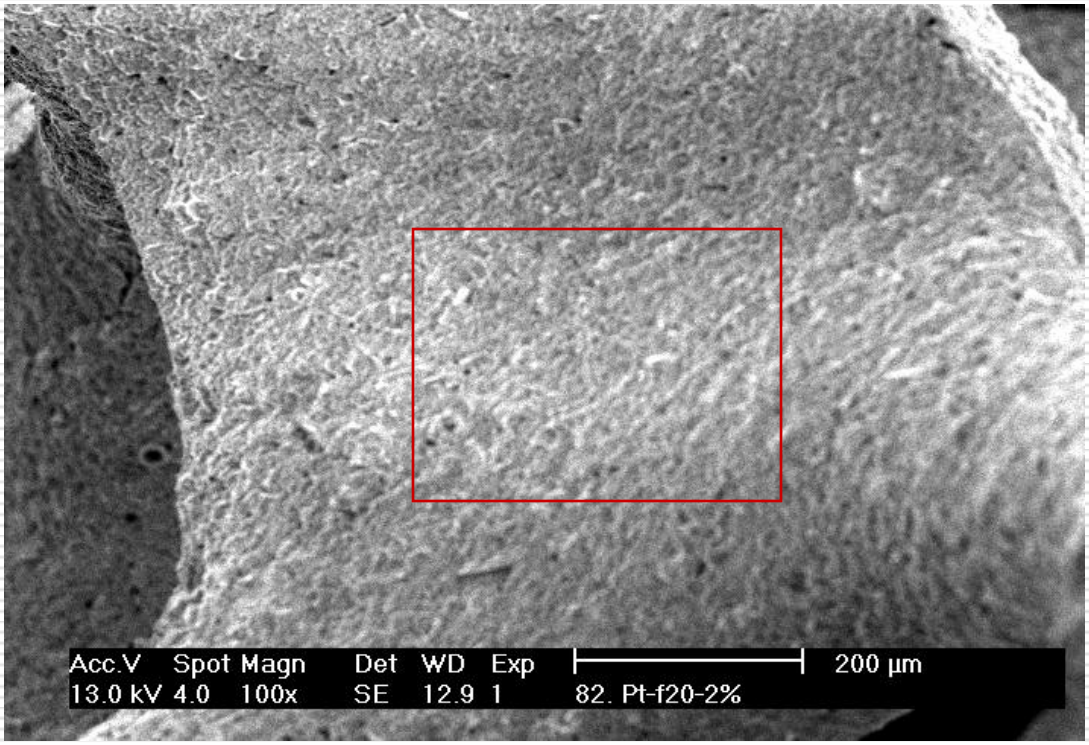
- Membrane SiC
- Perbesaran 200x

Pengantar: SEM



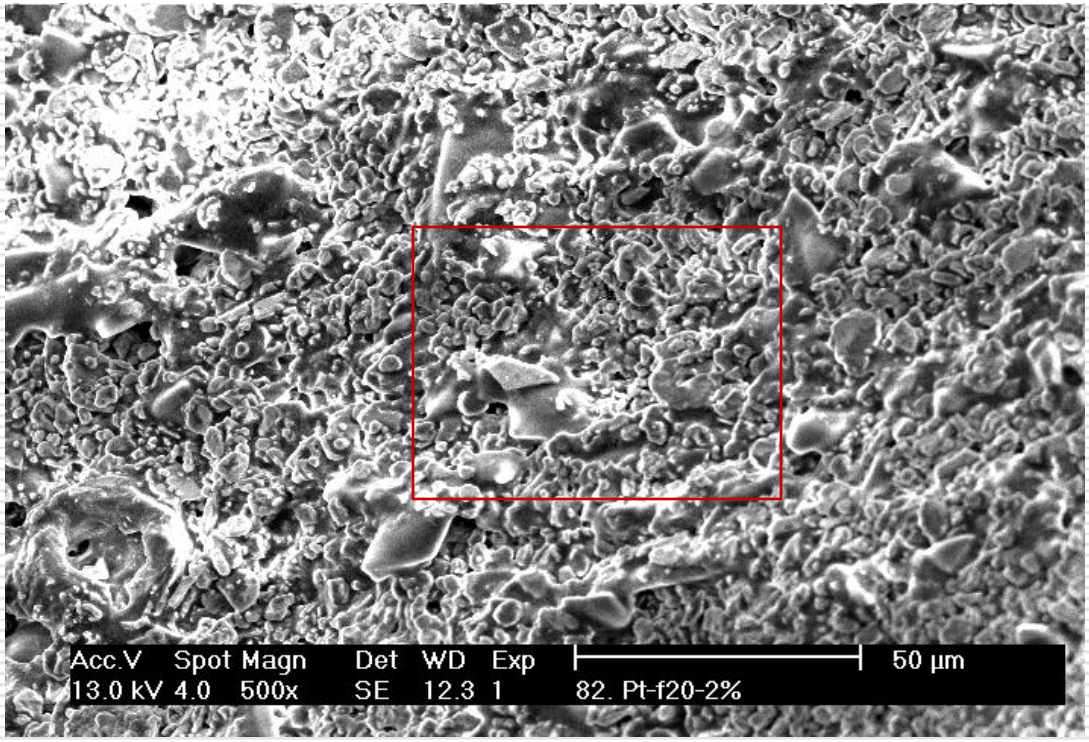
- Ceramic foam
- Perbesaran 20x

Pengantar: SEM



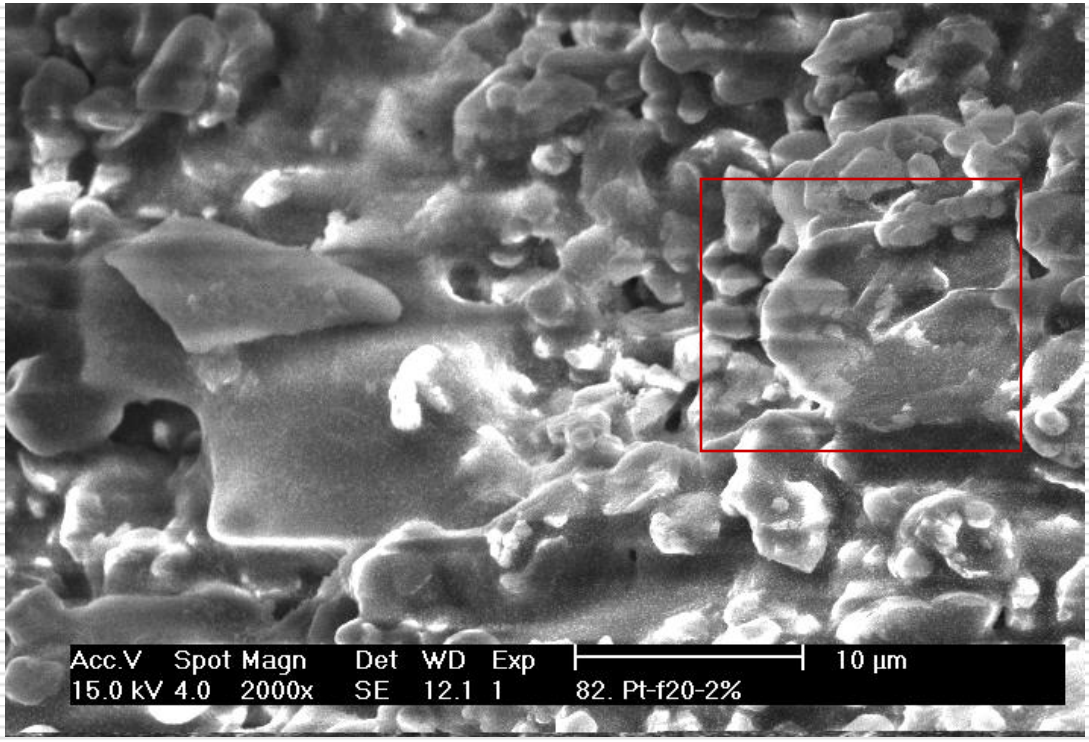
- Ceramic foam
- Perbesaran 100x

Pengantar: SEM



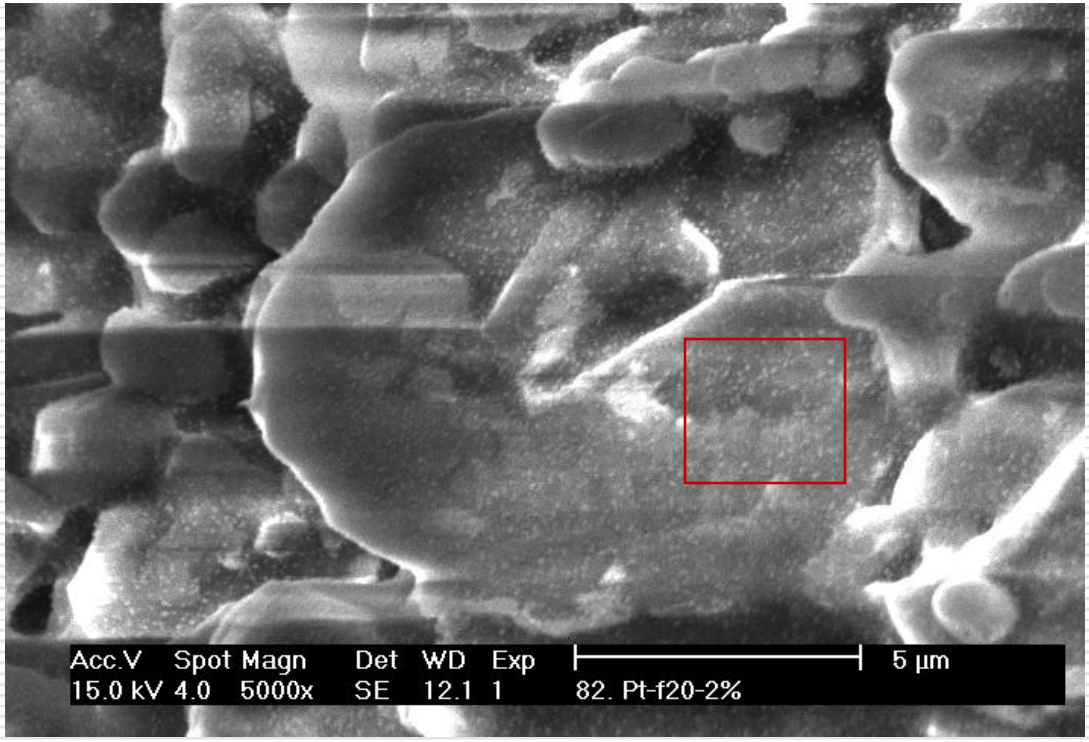
- Ceramic foam
- Perbesaran 500x

Pengantar: SEM



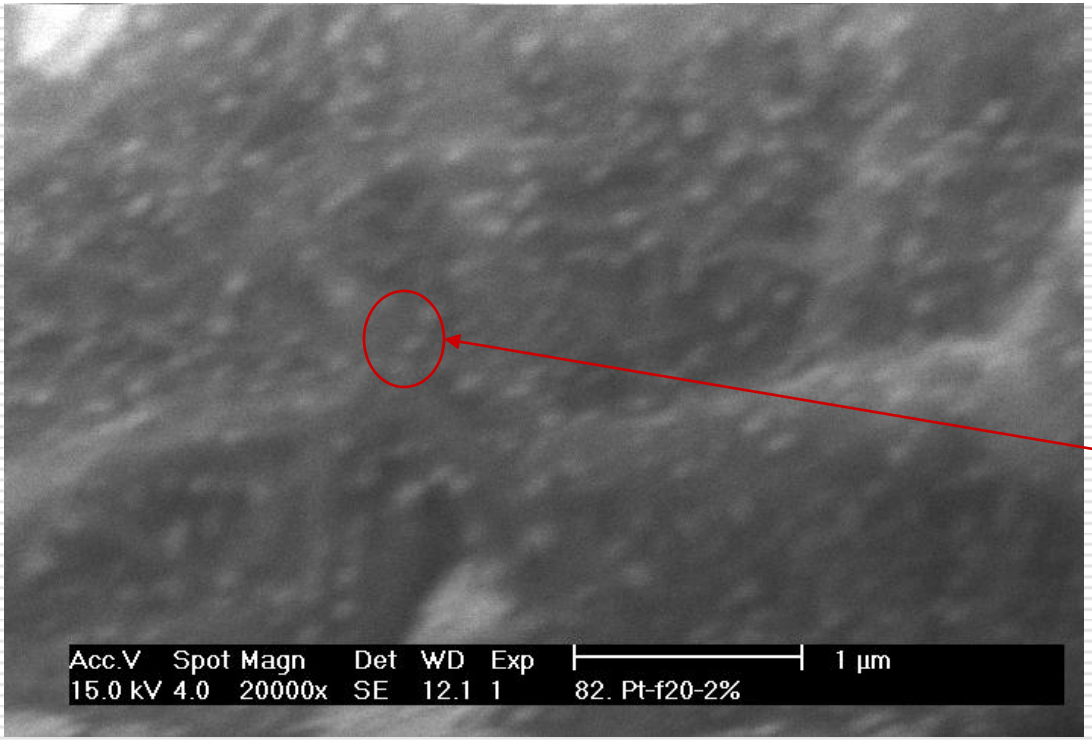
- Ceramic foam
- Perbesaran 2000x
- Partikel dapat dilihat pada skala micron

Pengantar: SEM



- Ceramic foam
- Perbesaran 5000x
- Partikel dapat dilihat pada skala micron

Pengantar: SEM



- Ceramic foam
- Perbesaran 20000x
- Partikel dapat dilihat pada skala ratusan nm

Pengantar: SEM

- Aplikasi:mempelajari morphology (sifat permukaan) suatu material:
  - Ukuran partikel/Chanel/Pori
  - Bentuk partikel/Pori
  - Pada SEM yang dilengkapi dengan EDX dapat pula ditentukan komposisi internal dari partikel
- Dasar: Interaksi berkas elektron-sample

Pengantar: SEM

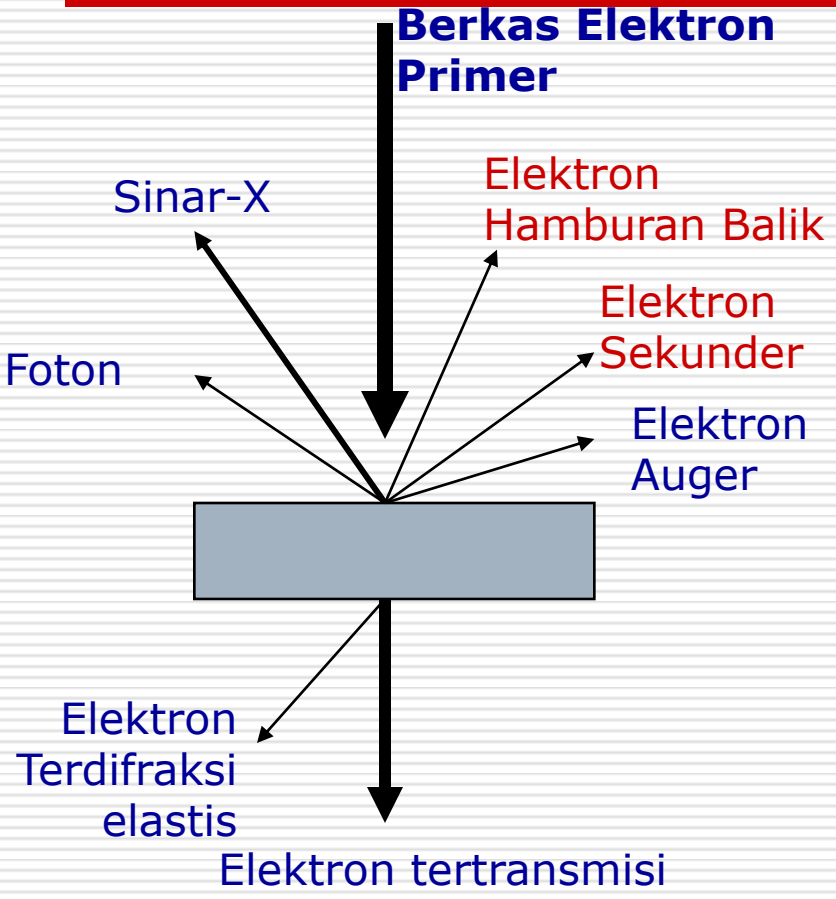
- Microscop Elektron;

  Jenis microscop yang mengunakan berkas elektron untuk mendapatkan image sample

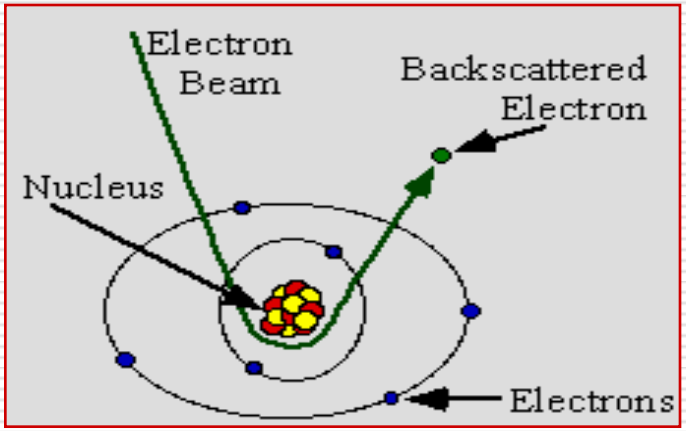
- Scanning Electron Microscopy,

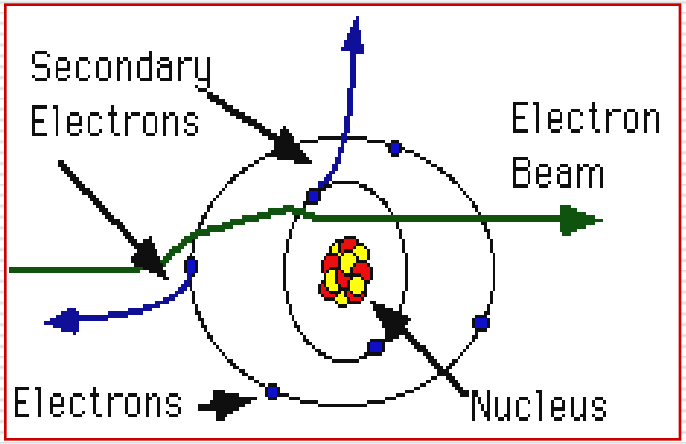
  Microscope Electron yang “memotret” material berdasarkan interaksi elektron dg permukaan material

Interaksi Berkas elektron dg Sample

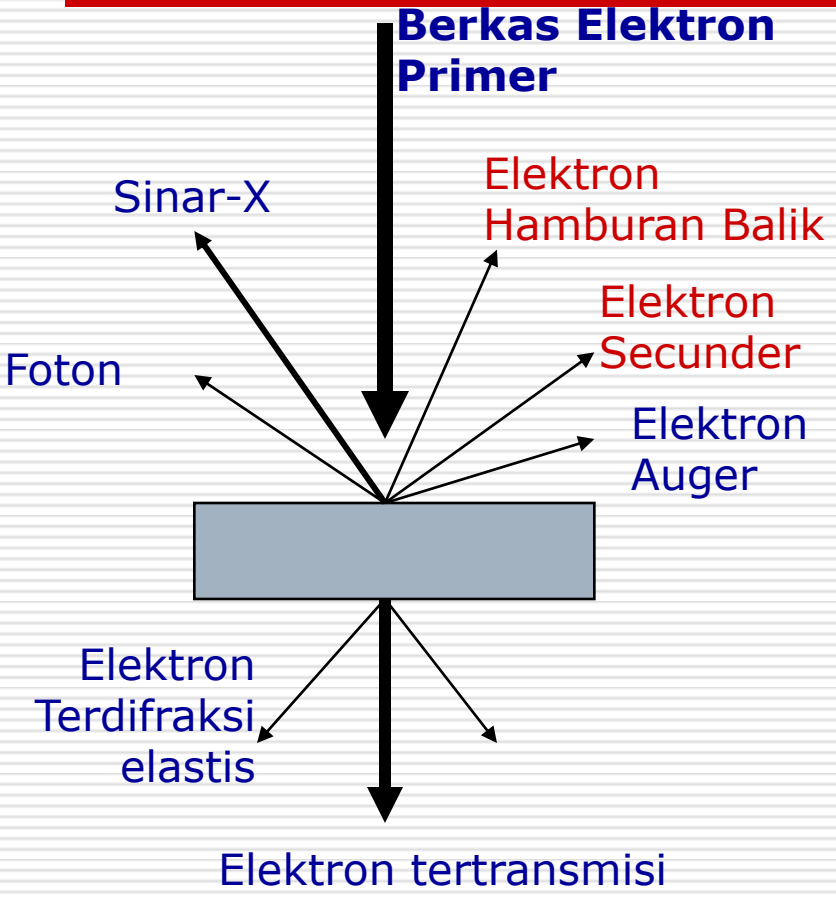


SEM

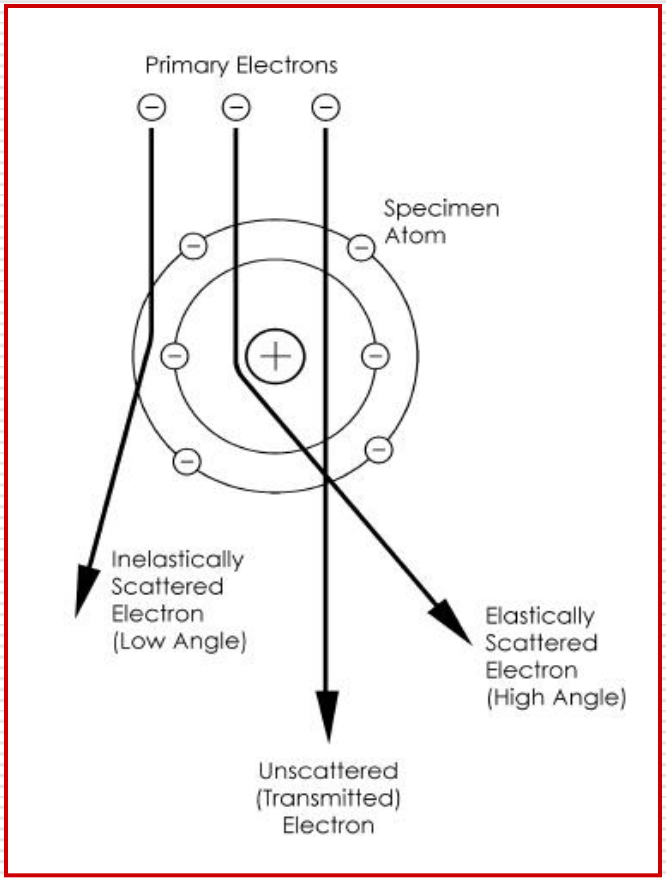




Interaksi Berkas elektron dg Sample



TEM

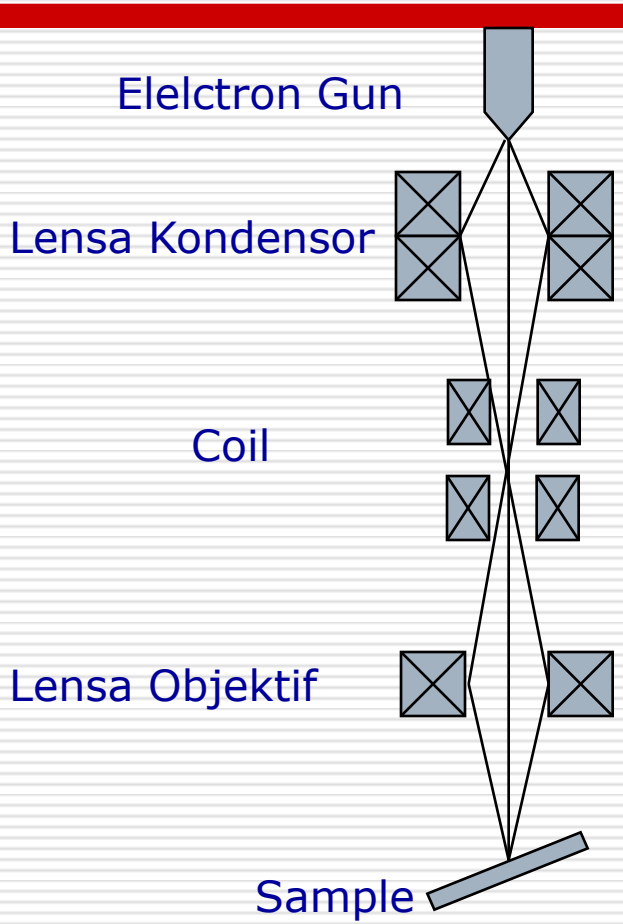


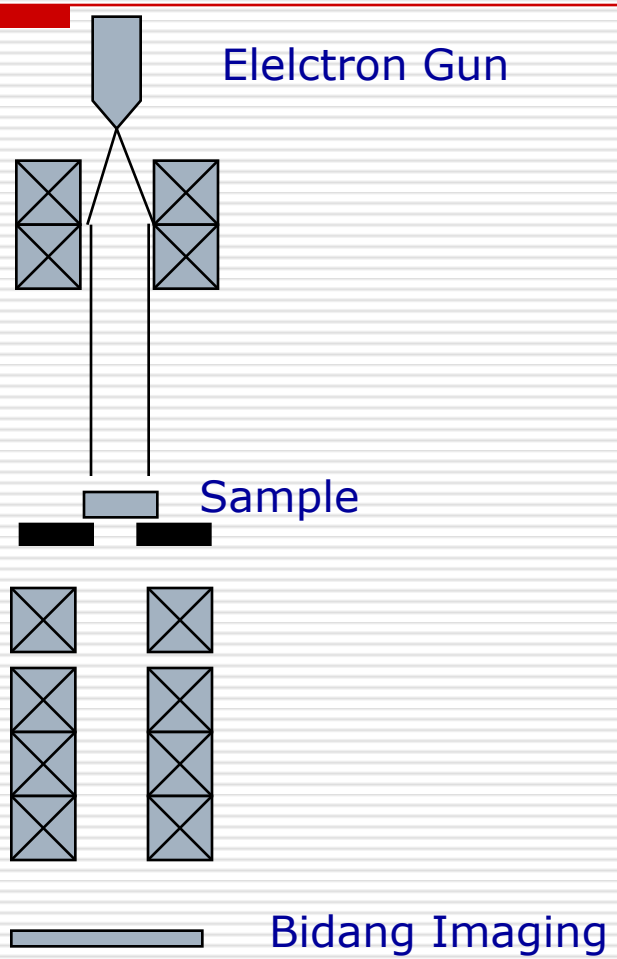
Overview

- Teknik Microscopy Elektron:
  - Scanning Electron Microscopy (SEM) *Memanfaatkan hamburan balik elektron*
  - Transmission Electron Microscopy (TEM)

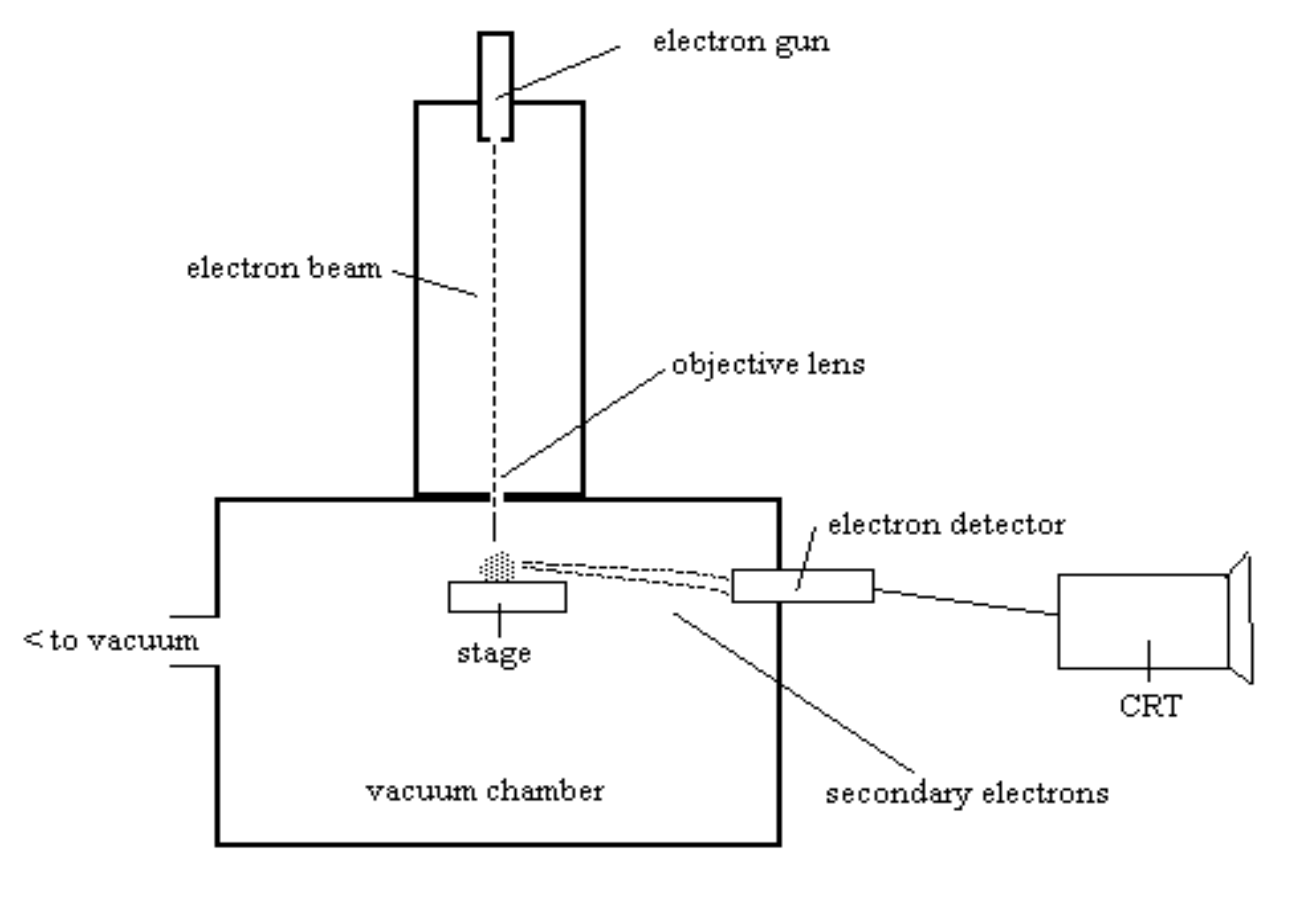
    Memanfaatkan hamburan elastis elektron transmisi

Prinsip Peralatan SEM/TEM

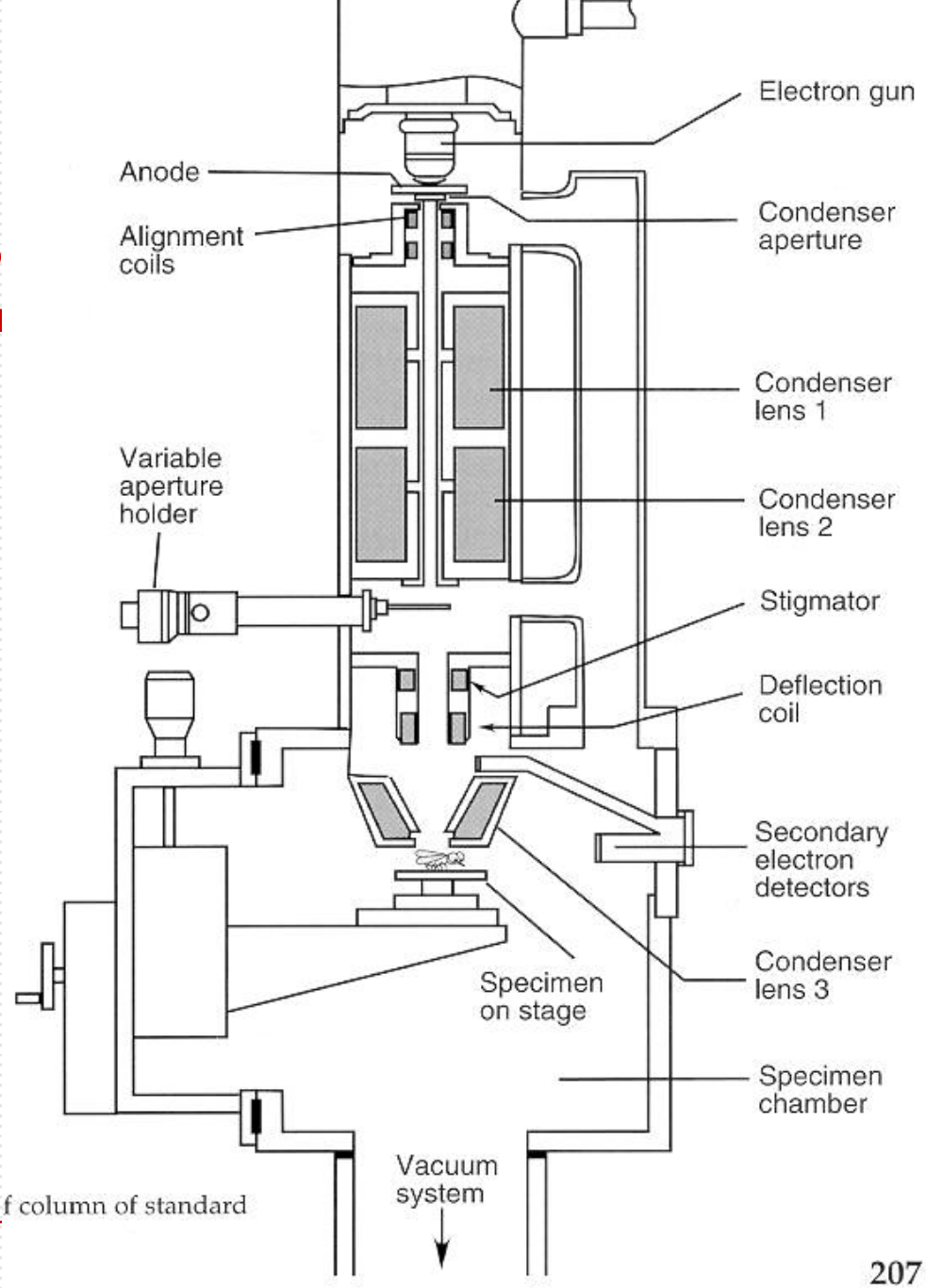




Prinsip Peralatan SEM

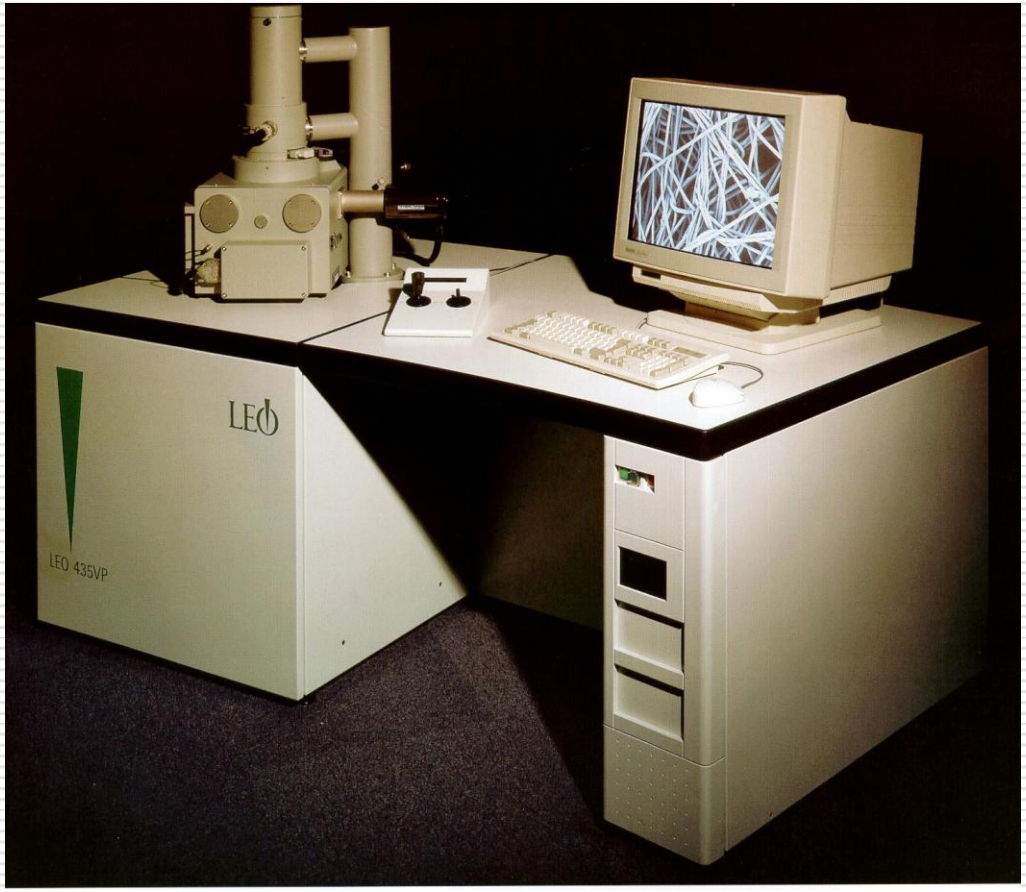


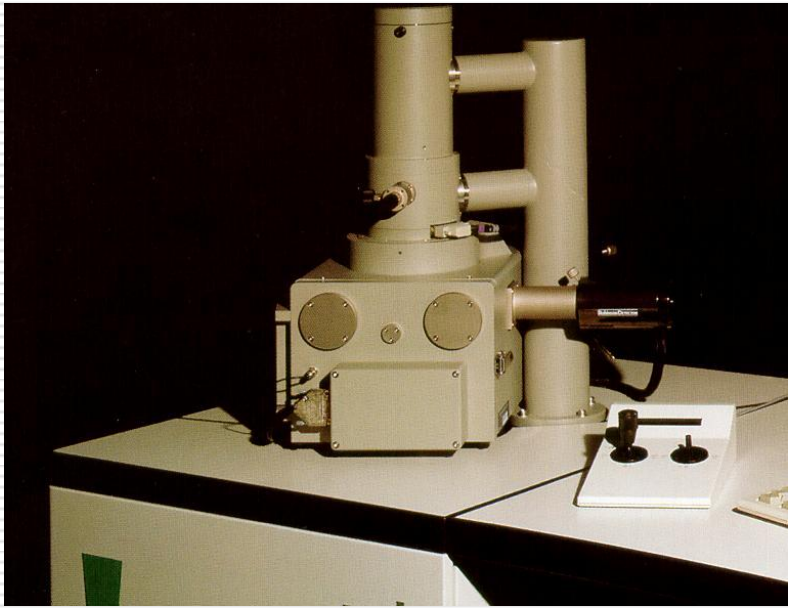
Gambar Teknis



f column of standard

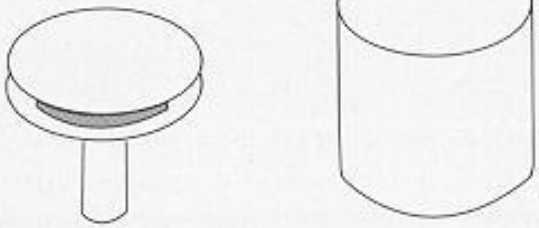
SEM

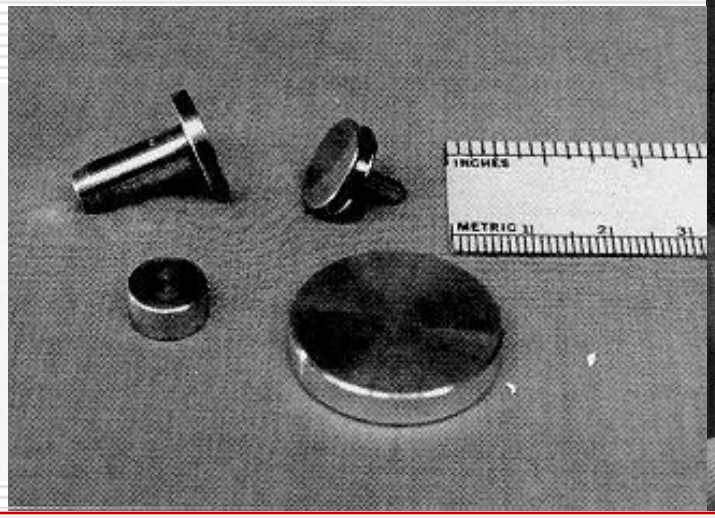


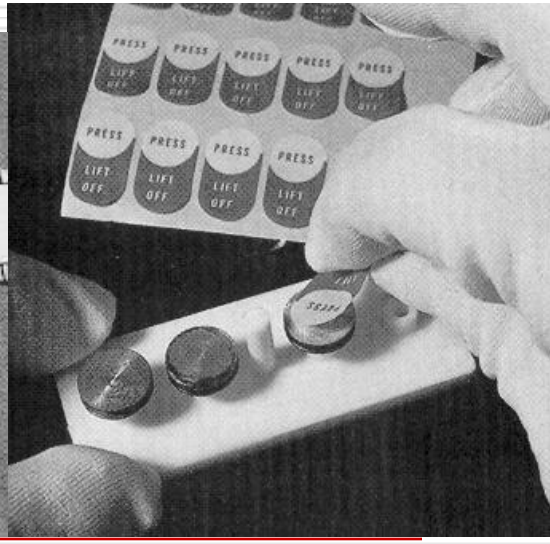


Penyiapan Sampel SEM

1. Bersihkan sample
2. Keringkan; dg vakum kalau mungkin (Sample harus bebas dari H_2O)
3. Tempatkan sample pada sample holder
4. Sputter dg Au atau Pt





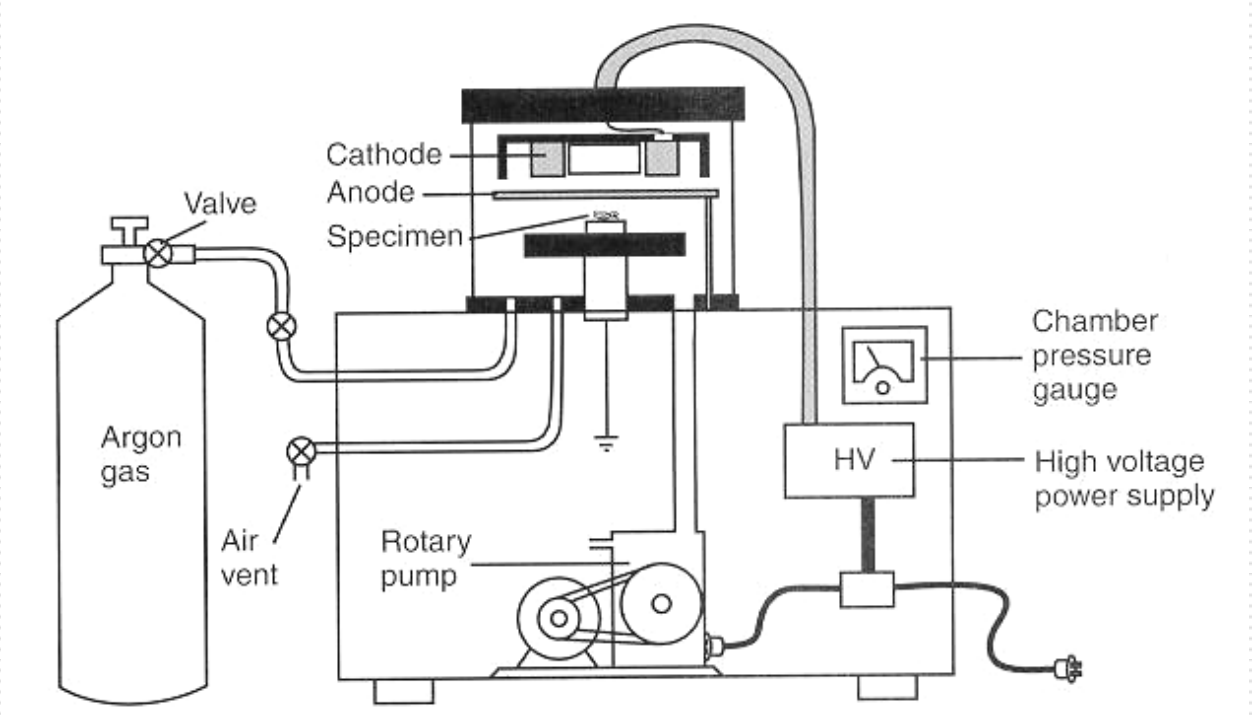


Penyiapan Sample

- Ukuran sample holder: 12 mm atau 25 mm
- Untuk menempelkan sample diperlukan double-sided tape konduktif
- Area yang dipelajari sebaiknya diletakan pada 45 degree
- Kontak area yang luas akan menguntungkan

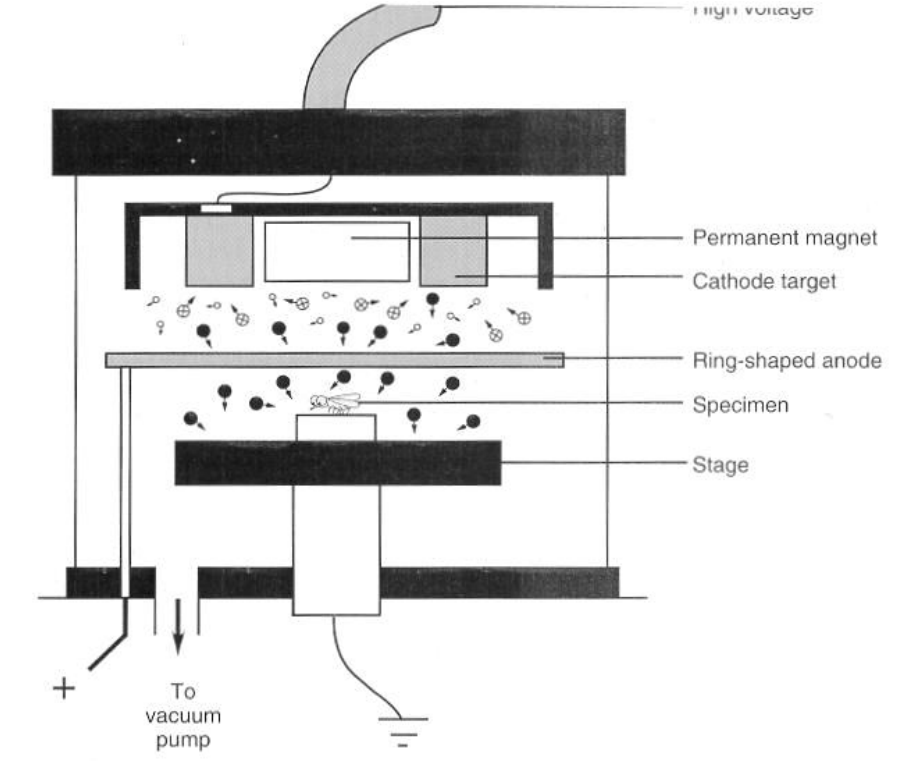
Sputtering

Untuk sample yang tidak bersifat konduktif, perlu dilakukan pelapisan dg Au



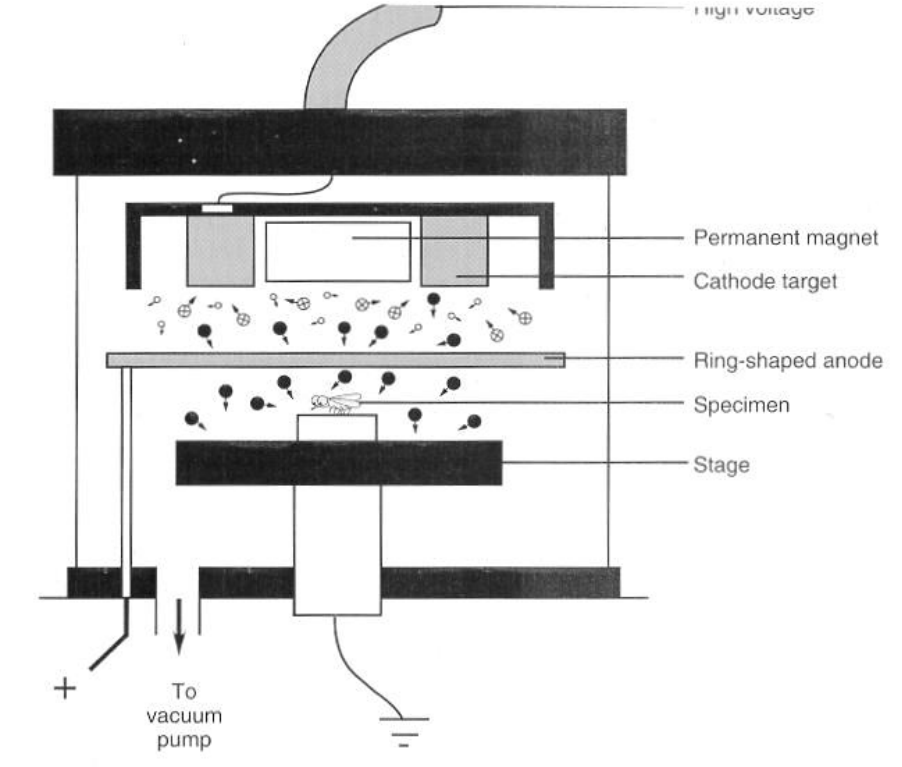
Cara Kerja Alat Sputering

- Logam (Au) sbg katoda
- Sample ditempatkan pada anode
- Gas Argon sbg atmospere
- Diterapkan beda potensial
- Cathode mengionisasi atom-atom Ar menjadi kation dan elektron
- Ion Argon ions terakselearsi ke arah katoda (Au)



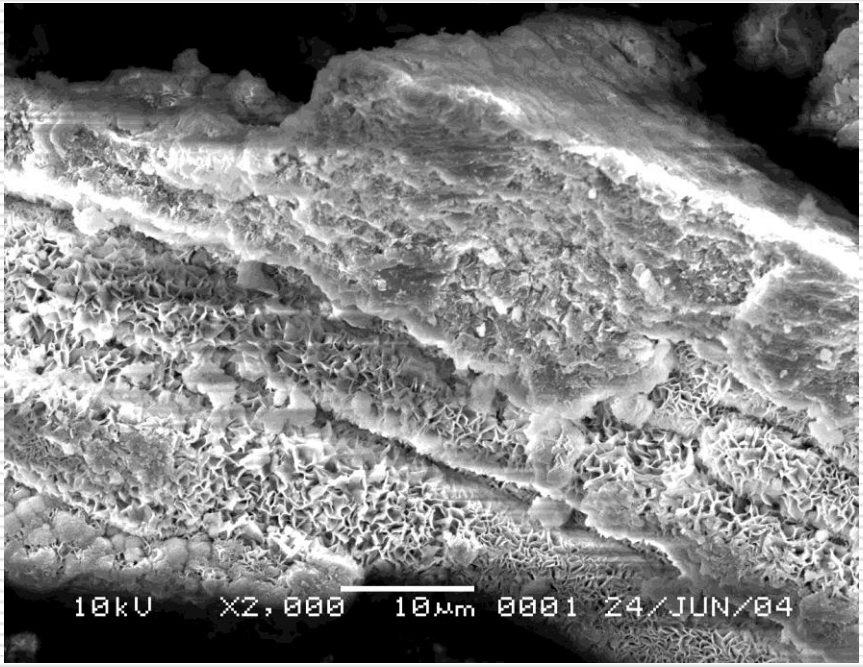
Cara Kerja Alat Sputering

- Atom Au dan elektron terhempas karena tumbukan
- Atom Au bertumbukan dengan ion Ar dan akhirnya melapisi sample dg ketebalan kira-kira 10-30 nm

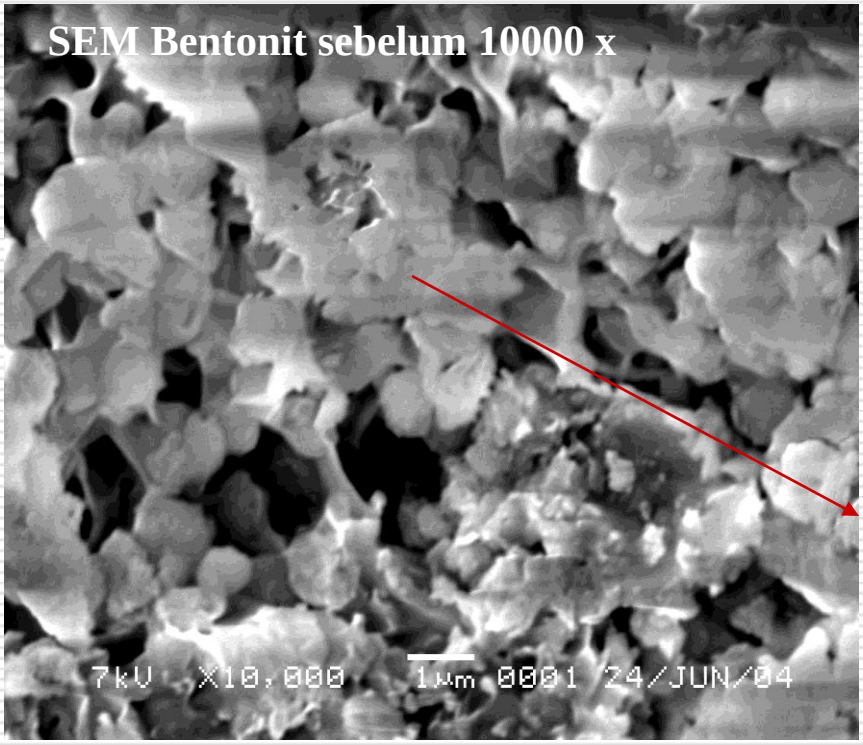


Advantage and Drawback

- Kelebihan
  - Preparasi sample cepat dan sederhana
  - Ukuran sample yang relatif besar
  - Rentang perbesaran yang luas: 3X - 150,000X
- Kekurangan
  - Dibanding TEM resolusinya lebih rendah
  - Digunakan vakum
  - Hanya permukaan yang teramati
  - Diperlukan coating dg Au

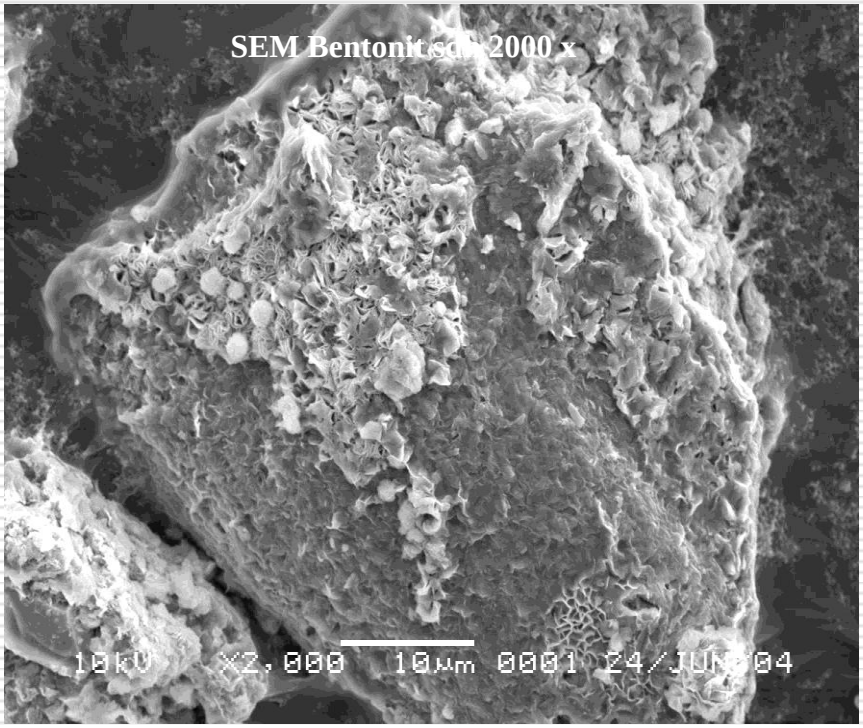

10kV X2,000 10µm 0001 24/JUN/04

Contoh Image SEM dari Bentonit

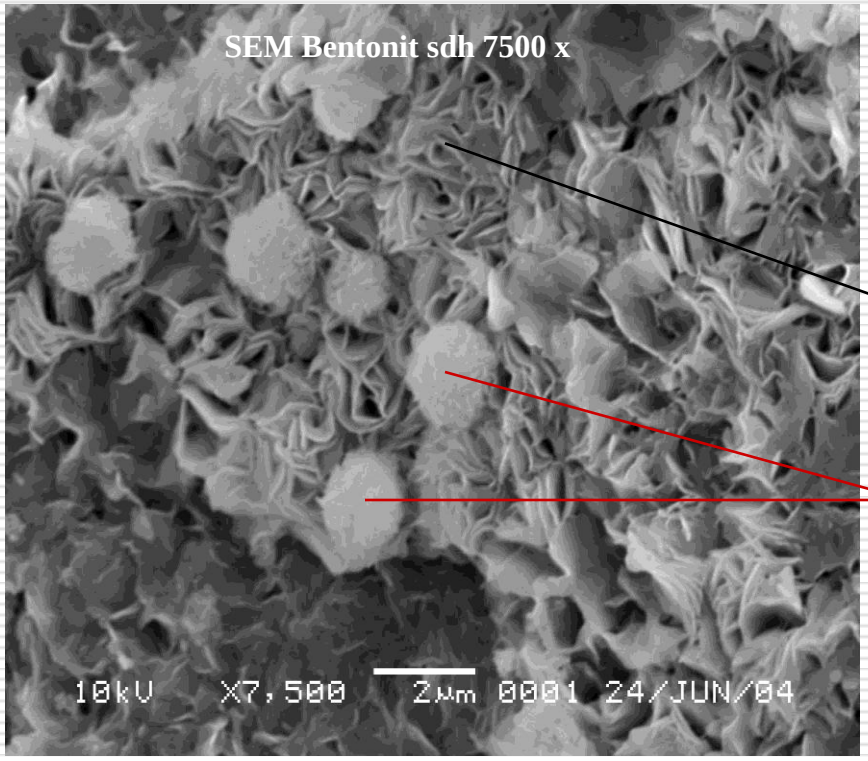


- SEM Image bentonit sebelum digunakan sebagai adsorbent
- Struktur dasar bentonit
- Diduga partikel komponen limbah

Contoh Image SEM dari Bentonit



Contoh Image SEM dari Bentonit



- SEM Image bentonit setelah adsorpsi limbah
- Struktur dasar bentonit
- Diduga partikel komponen limbah

Teknik Baru

- SEM-EDX; SEM-Energy dispersive

  Dapat digunakan untuk analisa unsur Spot yang diamati

- Environmental SEM

  Dapat digunakan untuk mengamatai perubahan morphologi pada berbagai temperatur