Observasi dengan SEM

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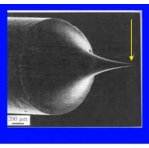
Outline

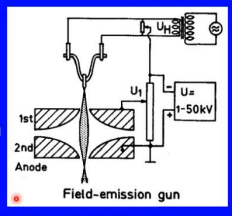
- Review perbedaan SEM dan FE-SEM
- Memahami gambar SEM
- **Memilih setting alat yang tepat**
- Bercerita dengan image

SEM vs FE-SEM

Field Emission Gun



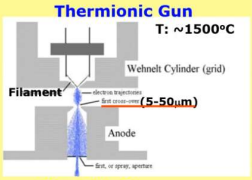
- The tip of a tungsten needle is made very sharp (radius < 0.1 µm)
- The electric field at the tip is very strong (> 10^7 V/cm) due to the sharp point effect
- Electrons are pulled out from the tip by the strong electric field
- Ultra-high vacuum (better than 10^{-6} Pa) is needed to avoid ion bombardment to the tip from the residual gas.
- Electron probe diameter < 1 nm is possible



1st anode to regulate the field strength at the tip by U1 and hence regulate the emission current.
2nd anode: accelerates the electrons to the final kinetic energy.

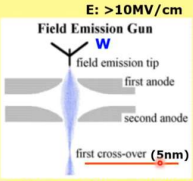
Source of Electrons

Thermionic Gun — T: ~1500°C



W and LaB_6

Field Emission Gun — E: >10MV/cm



Cold- and thermal FEG

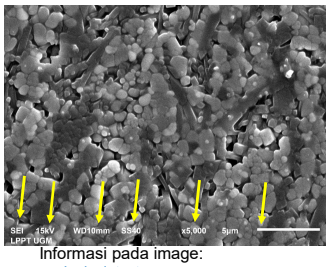
Electron Gun Properties

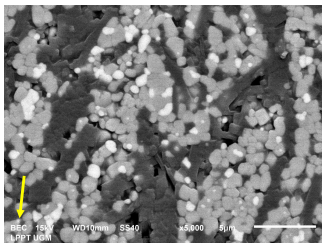
Source	Brightness	Stability(%)	Size	Energy spread	Vacuum
W	$3X10^5$	~1	50µm	3.0(eV)	10^{-5} (τ)
LaB_6	$3x10^6$	~2	5µm	1.5	10^{-6}
C-FEG	10^9	~5	5nm	0.3	10^{-10}
T-FEG	10^9	<1	20nm	0.7	10^{-9}

Brightness – beam current density per unit solid angle

Membaca image SEM

Contoh: Struktur keramik

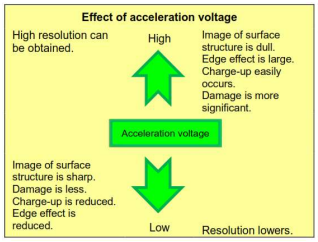


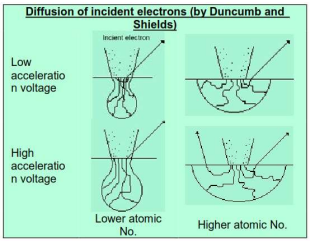


Informasi pada image:

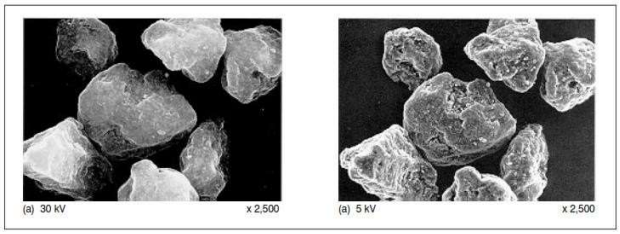
- Jenis detector
- Tegangan yg dipakai
- Working distance
- Spot size
- Perbesaran
- Scaler (mistar bar).

Kualitas gambar berbeda jika level tegangan berbeda





Effect of Accelerating Voltage



Specimen: Toner

When high accelerating voltage is used as at (a), it is hard to obtain the contrast of the specimen **surface structure**. Besides, the specimen surface is easily charged up. The surface microstructures are easily seen at (b).

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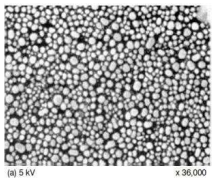
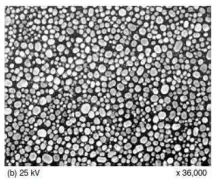
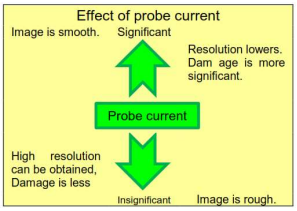




Specimen: Evaporated Au particles

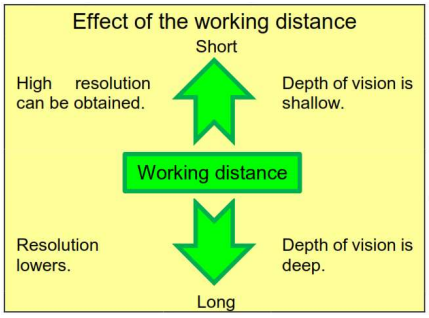
The image sharpness and resolution are better at the higher accelerating voltage, 25 kV.

Efek Probe Current

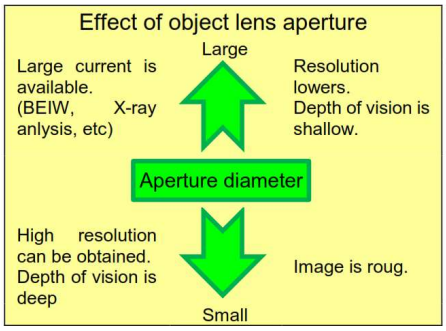


Indication of setting an probe current			
P.C.value	0	⟷	99.9
Resolution	High	⟷	Low
Probe diameter	Small	⟷	Large
Probe current	Small	⟷	Large
Condenser lens current	Large	⟷	Small
Specimen damage	Insignificant	⟷	Significant
Image quality	Rough	⟷	Smooth

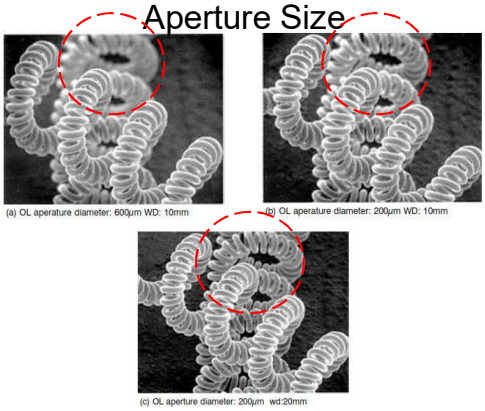
Efek Working Distance (WD) pada image



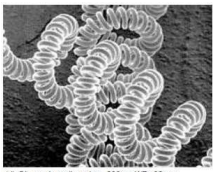
Diamete aperture terhadap image

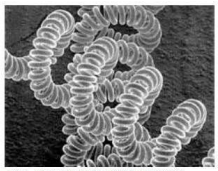


Influence of Working Distance and Aperture Size



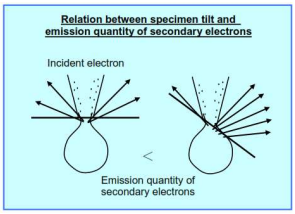
Influence of Working Distance and Aperture Size

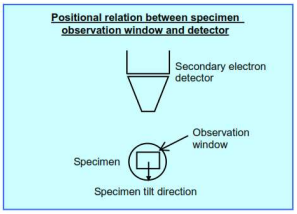

(d) OL aperture diameter: 200μm WD: 38mm


(e) OL aperture diameter: 100μm WD: 38mm

Specimen Electric bulb coil
5 kV x540
The smaller the OL aperture diameter and the longer the WD, the greater the depth of field.

Pengamatan Sample non conductive





Tip dan trik sample

- Menentukan jenis sample: untuk memahami preparasi yg cocok
- Menentukan titik yang akan diamati: permukaan atau cross section
- Conduktif atau non conduktif
- Mengatur setting alat
- Pengaturan khusus utk EDS dan mapping
- Analisis menyeluruh

Topography and morphology

- High depth of focus

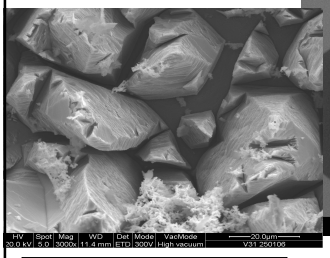


Image: Christian Kjølseth, UiO

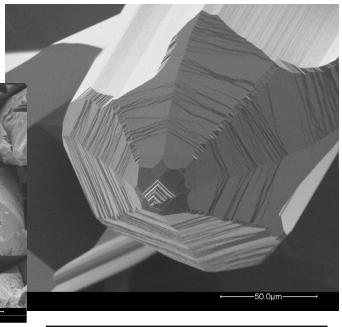
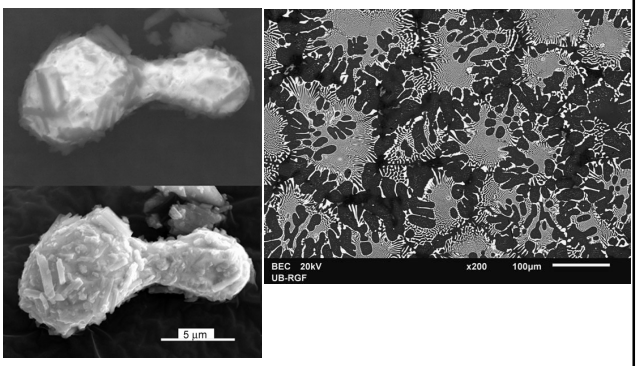


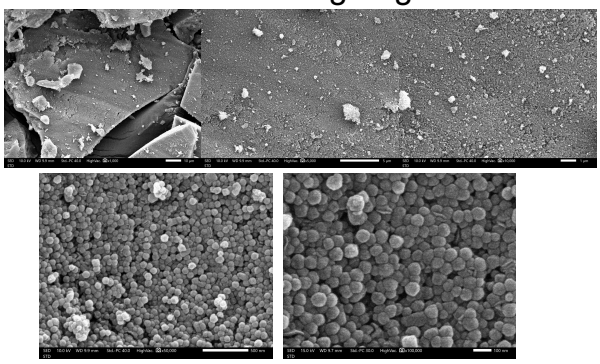
Image: Camilla Kongshaug, UiO

BSE vs SE



Images: Greg Meeker, USGS

Bercerita dengan gambar



Contoh sample lempung