SCANNING ELECTRON MICROSCOPE (SEM)

SCANNING ELECTRON MICROSCOPE

SCANNING ELECTRON MICROSCOPE

- Scanning Electron Microscope (SEM) digunakan untuk pengamatan permukaan spesimen.
- Ketika suatu spesimen disinari dengan berkas elektron yang halus (disebut electron probe), elektron sekunder dipancarkan dari permukaan spesimen.
- Topografi dari permukaan spesimen kemudian dapat diamati dengan pemindaian (scanning) dua dimensi electron probe di atas permukaan spesimen. Permukaan spesimen juga dapat diperoleh melalui gambar dari elektron sekunder yang terdeteksi.

SCANNING ELECTRON MICROSCOPE

1. **Topography**

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

2. **Morphology**

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

3. **Composition**

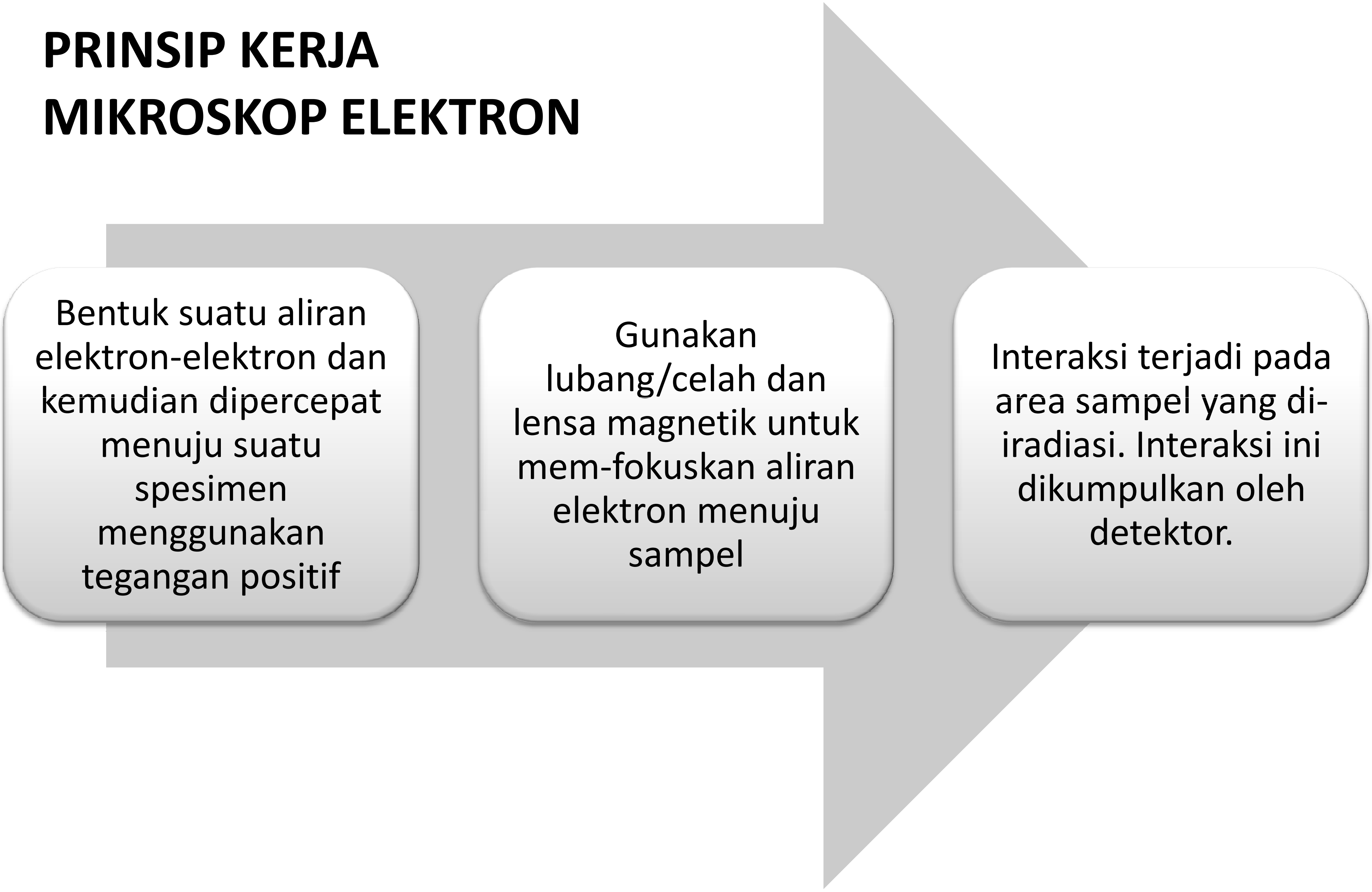
   The elements and compounds that the object is composed of and the relative amounts of them; direct relationship between composition and materials properties

4. **Crystallographic Information**

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

SCANNING ELECTRON MICROSCOPE

PRINSIP KERJA MIKROSKOP ELEKTRON

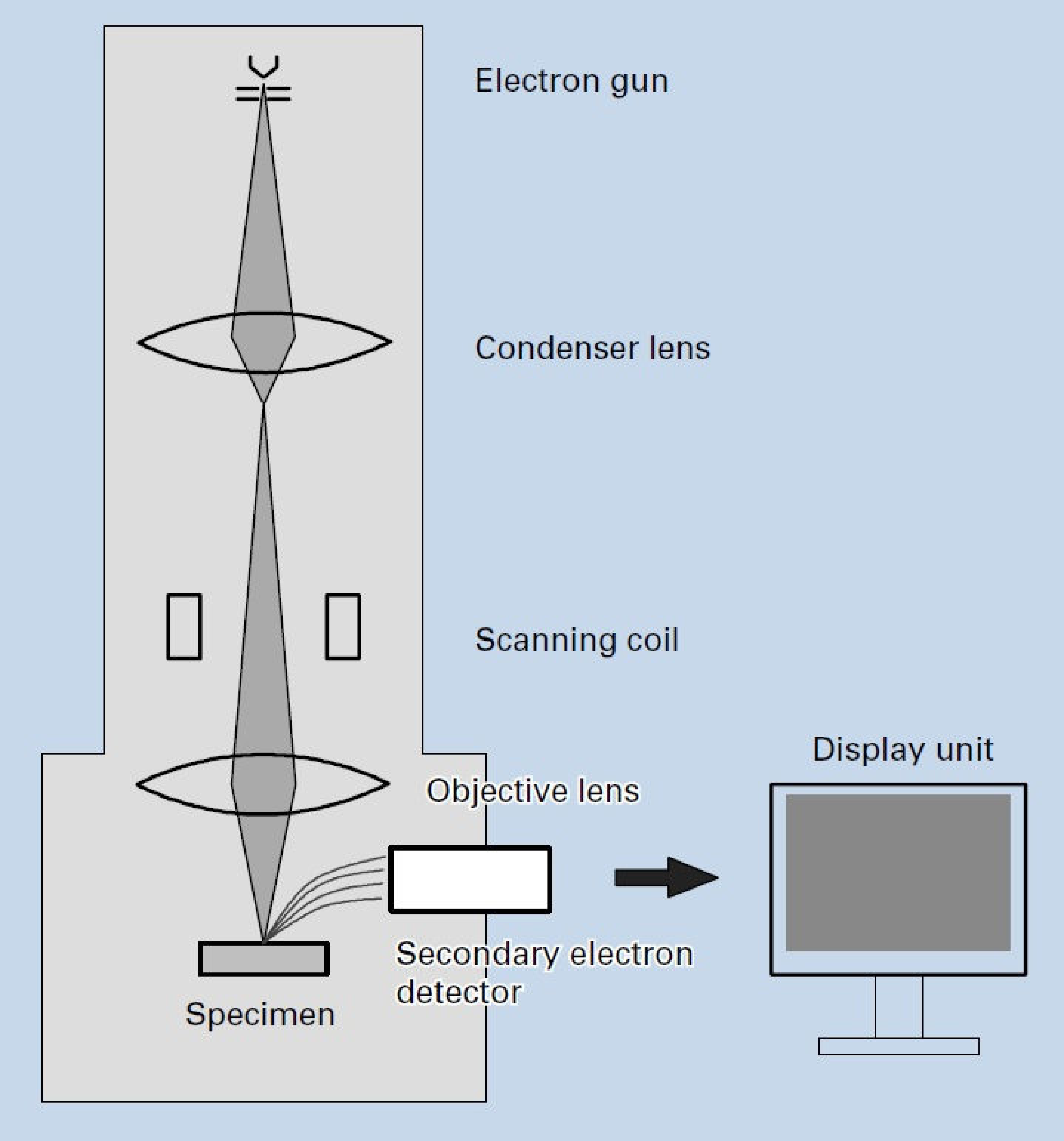


Bentuk suatu aliran elektron-elektron dan kemudian dipercepat menuju suatu spesimen menggunakan tegangan positif

Gunakan lubang/celah dan lensa magnetik untuk mem-fokuskan aliran elektron menuju sampel

Interaksi terjadi pada area sampel yang di-iradiasi. Interaksi ini dikumpulkan oleh detektor.

KONSTRUKSI INSTRUMEN SEM

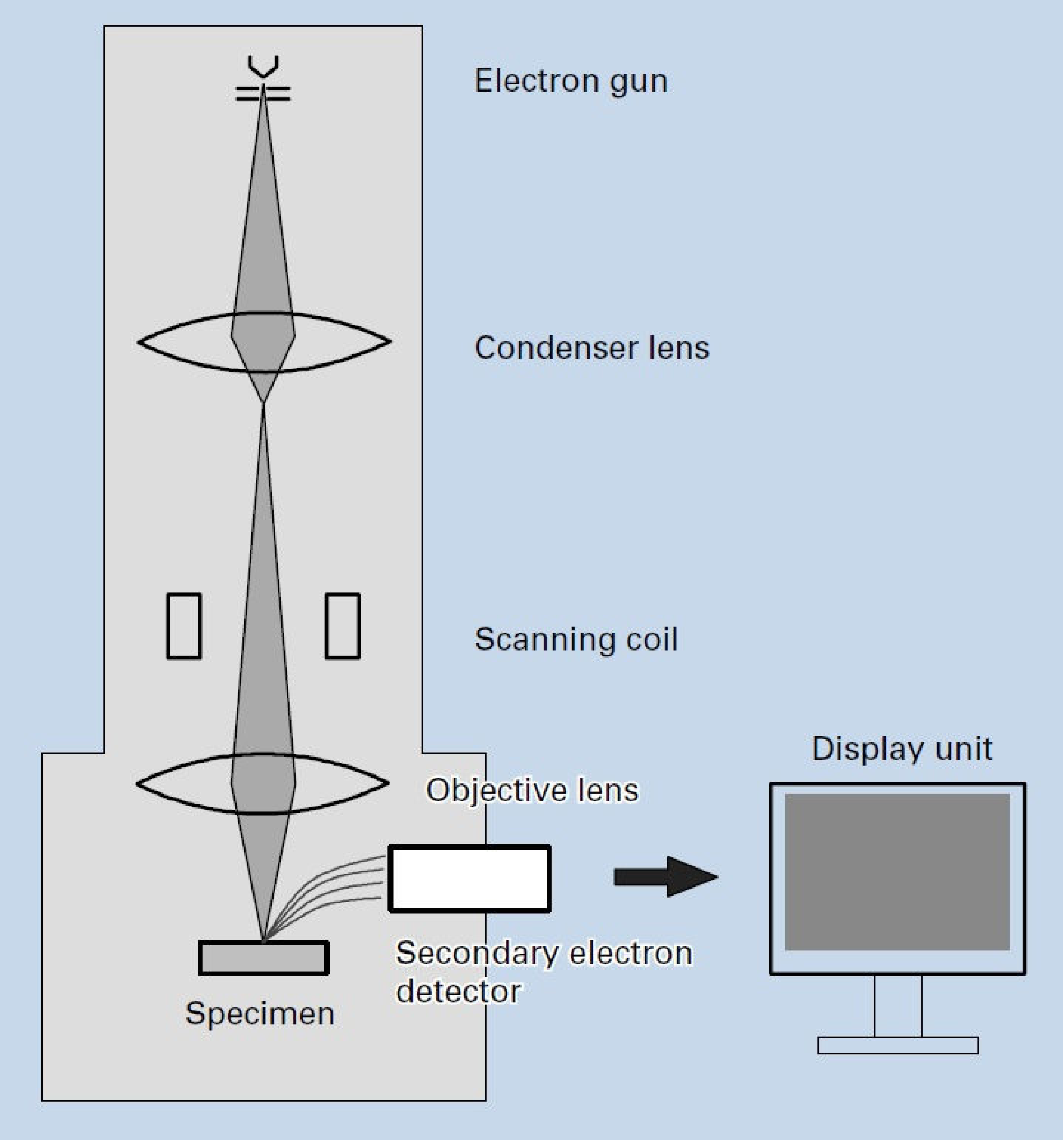


Konstruksi Dasar SEM

Instrumen SEM terdiri dari:

- Sistem optik elektron untuk menghasilkan electron probe
- Specimen stage untuk menempatkan spesimen
- Detektor elektron sekunder (secondary-electron detector) untuk mengumpulkan elektron-elektron sekunder
- Image display unit
- Sistem operasi untuk melakukan berbagai tugas

KONSTRUKSI INSTRUMEN SEM



Konstruksi Dasar SEM

Electron Optical System terdiri dari:

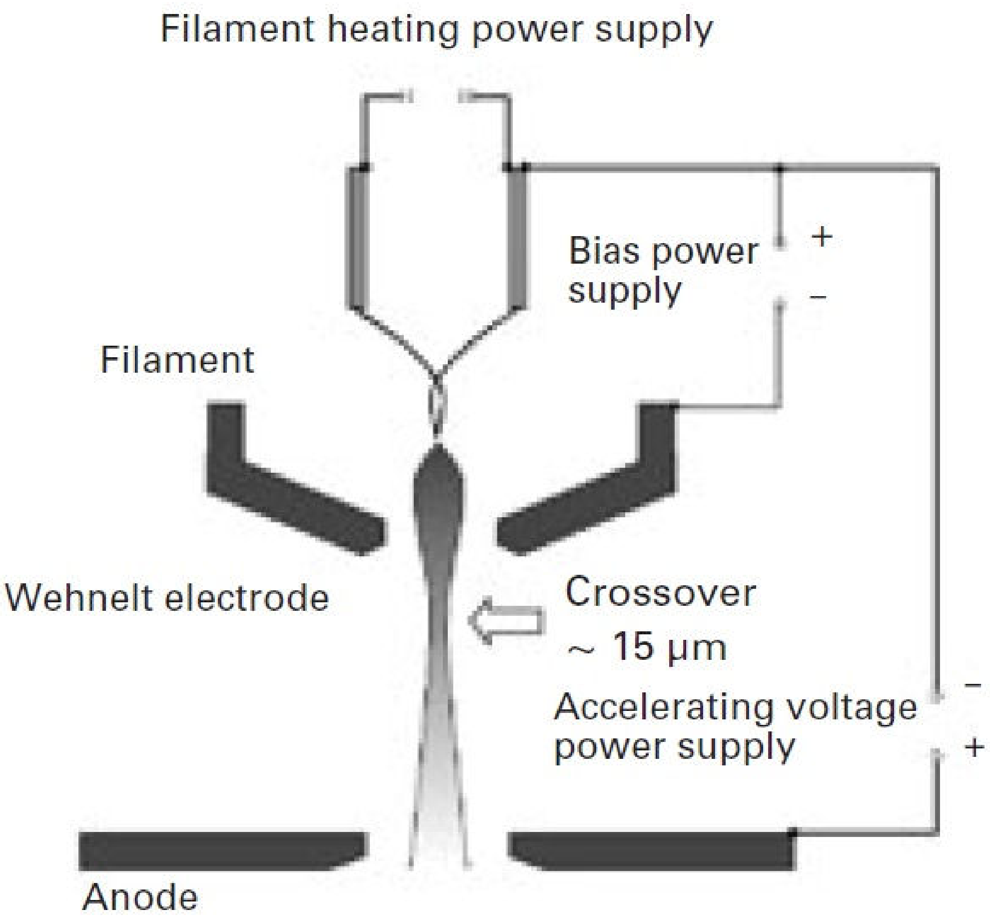
- Electron gun
- Condenser lens
- Objective lens untuk menghasilkan electron probe
- Scanning coil untuk memindai electron probe

Electron Optical System yang terletak didalam kolom mikroskop dan ruang kerja spesimen dijaga dalam keadaan vakum.

KONSTRUKSI INSTRUMEN SEM

ELECTRON GUN

a device for producing a narrow stream of electrons from a heated cathode



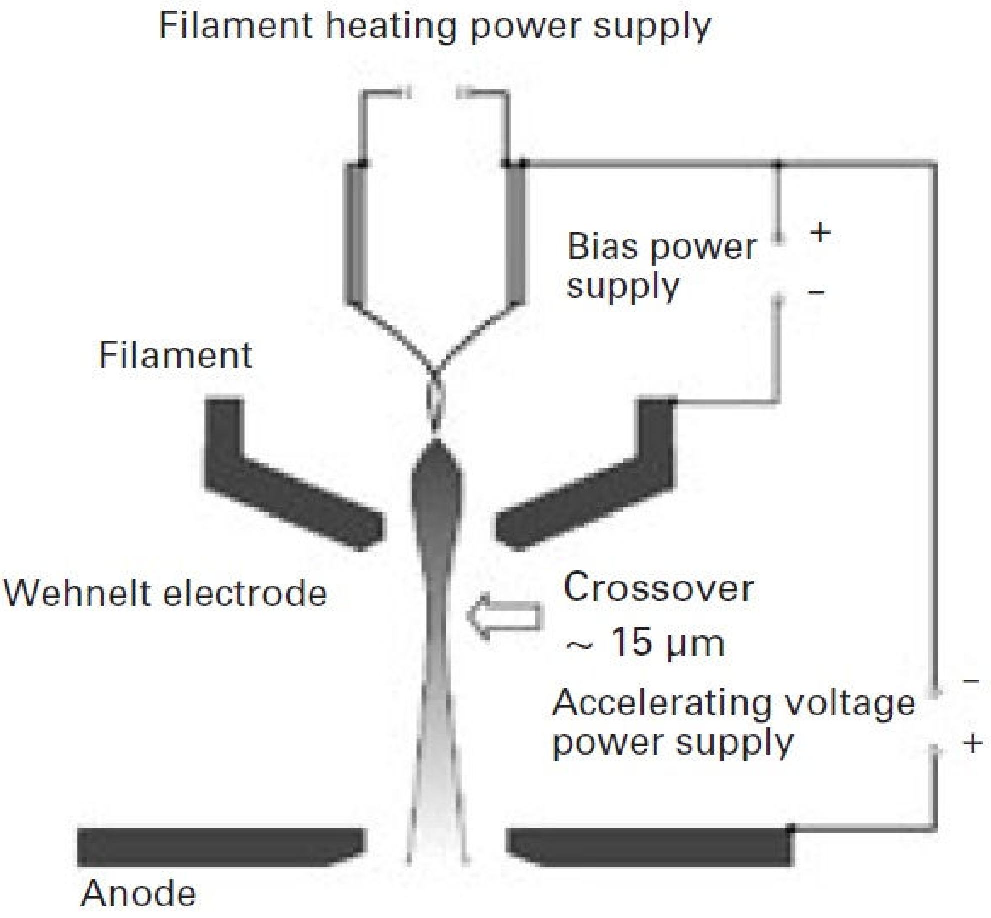
Konstruksi dari Electron Gun
(Jenis Thermionic Emission Gun / TE Gun)

- Electron Gun menghasilkan electron beam
- Thermoelectron memancar dari filamen (katoda) yang terbuat dari tungsten wire yang tipis (~ 0,1 mm) melalui pemanasan filamen pada temperatur tinggi (~ 2800 K)
- Thermoelectron ini akan berkumpul menjadi suatu electron beam, yang mengalir menuju pelat logam (anoda) dengan menerapkan tegangan positif (1 – 30 kV) menuju anoda

KONSTRUKSI INSTRUMEN SEM

ELECTRON GUN

- Jika sebuah lubang dibuat ditengah anoda, maka elektron akan mengalir melalui lubang tsb
- Ketika kita menempatkan elektroda (disebut elektroda Wehnelt) diantara katoda dan anoda kemudian memberikan tegangan negatif, maka arus dari electron beam dapat diatur
- Titik terkecil pada beam disebut crossover, dan ini dianggap sebagai sumber aktual elektron dengan diameter antara 15 hingga 20 μm.

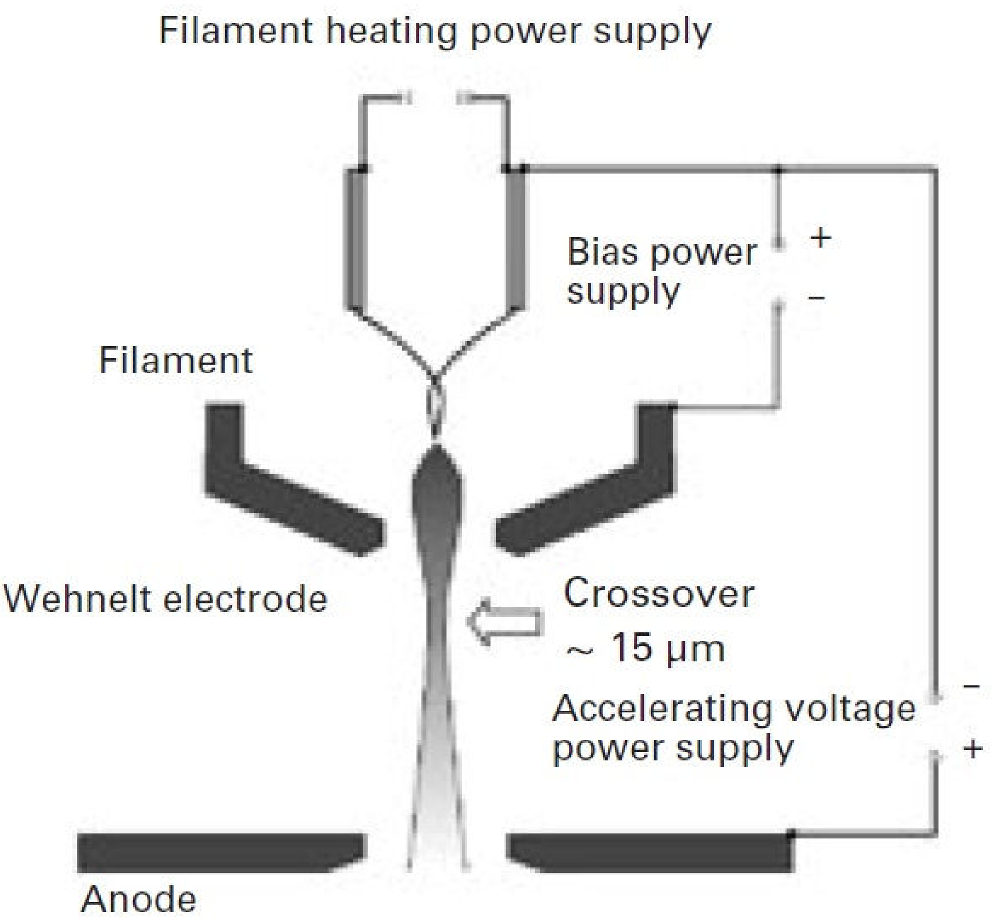


Konstruksi dari Electron Gun
(Jenis Thermionic Emission Gun / TE Gun)

KONSTRUKSI INSTRUMEN SEM

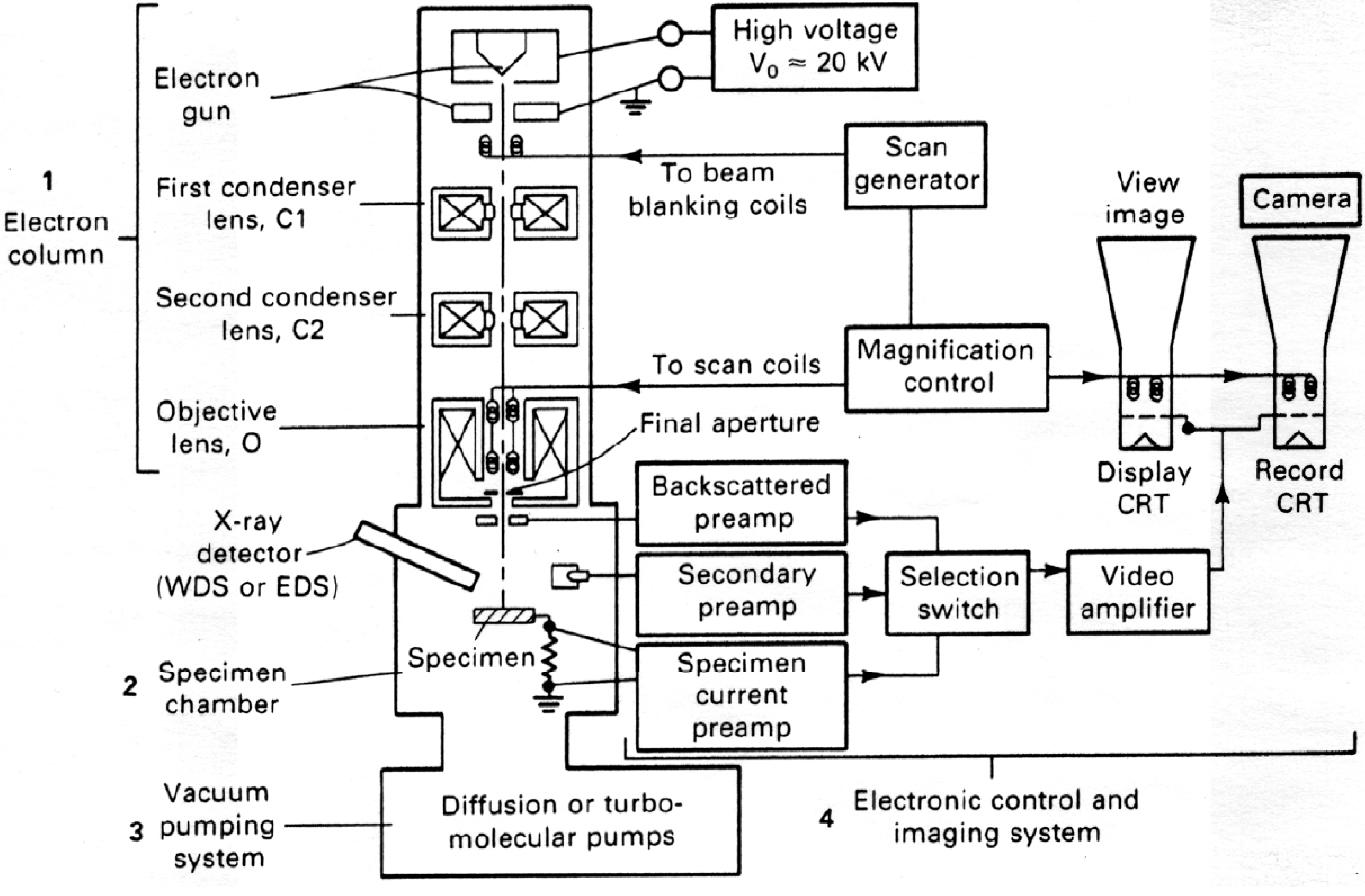
ELECTRON GUN

- TE gun merupakan electron gun yang paling banyak digunakan.
- LaB6 single crystal juga digunakan sebagai katoda namun memerlukan higher vacuum karena aktivitasnya yang tinggi
- Elctron gun lainnya adalah field-emission electron gun (FE gun) atau Schottky-emission gun (SE gun)

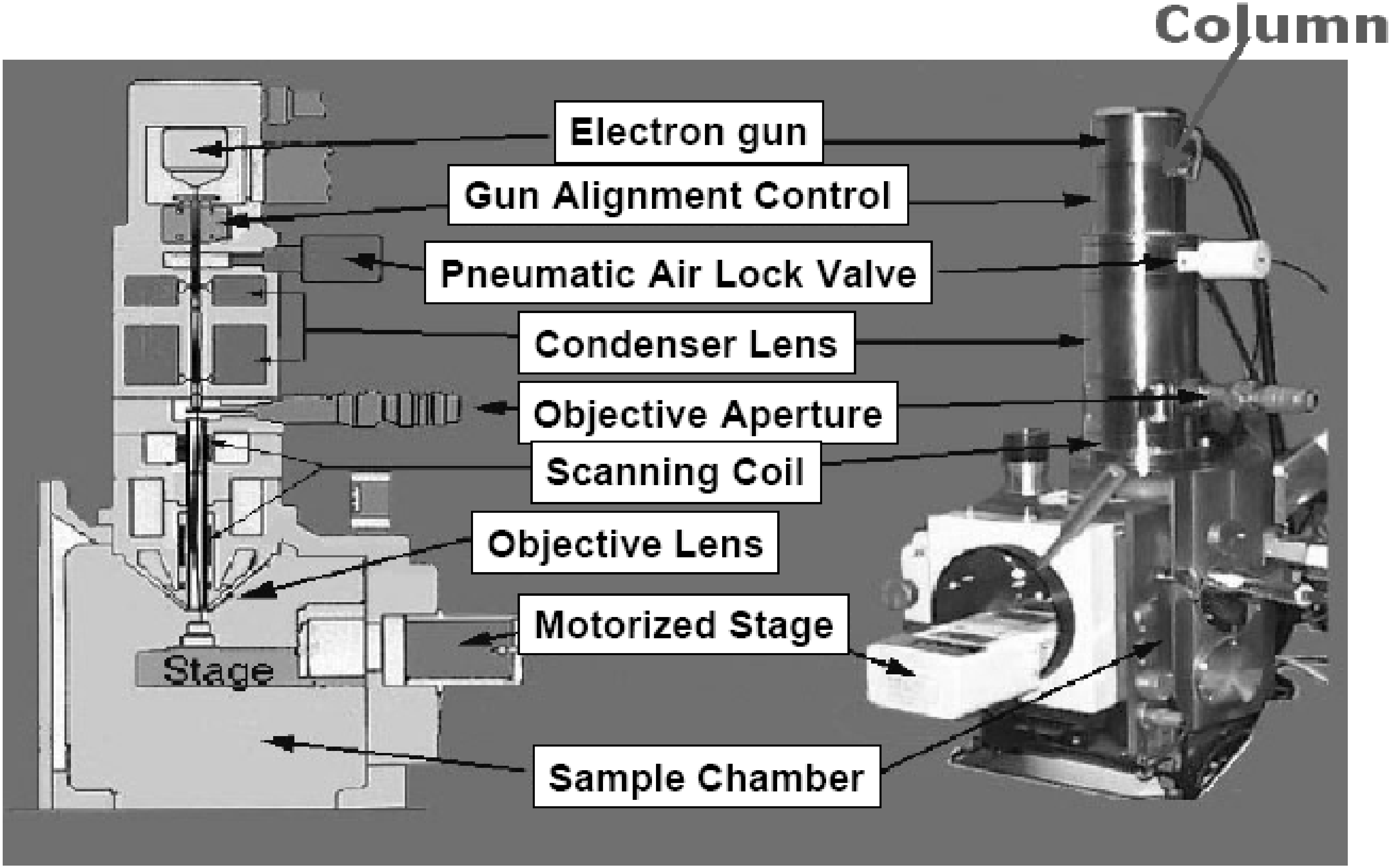


Konstruksi dari Electron Gun
(Jenis Thermionic Emission Gun / TE Gun)

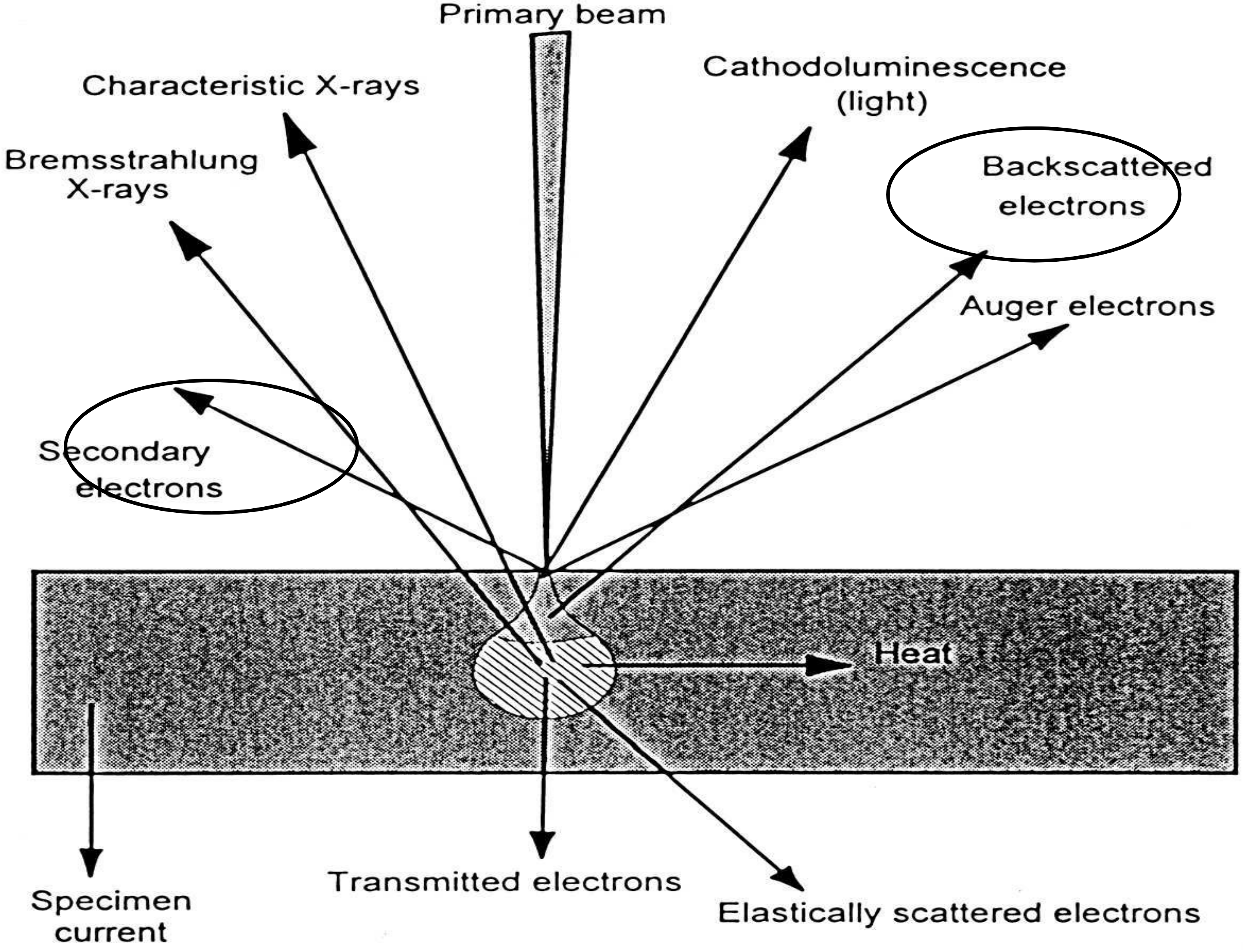
KONSTRUKSI INSTRUMEN SEM



KONSTRUKSI INSTRUMEN SEM



Electron beam – Specimen Interaction. Note the two types of electrons produced.



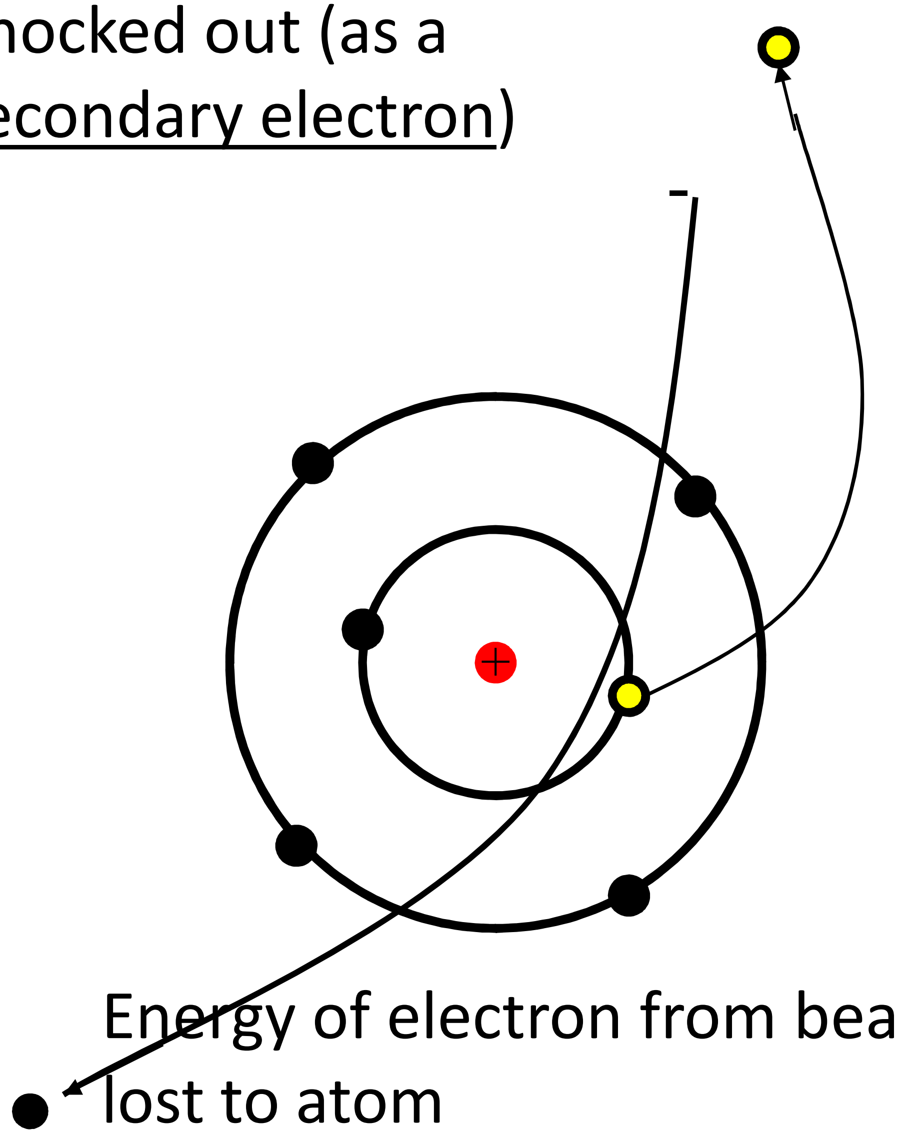
Electron beam – Specimen Interaction

Electrons from the focused beam interact with the sample to produce a spray of electrons up from the sample. These come in two types – either secondary electrons or backscattered electrons.

As the beam travels across (scans across) the sample the spray of electrons is then collected little by little and forms the image of our sample on a computer screen.

We can look more closely at these two types of electrons because we use them for different purposes.

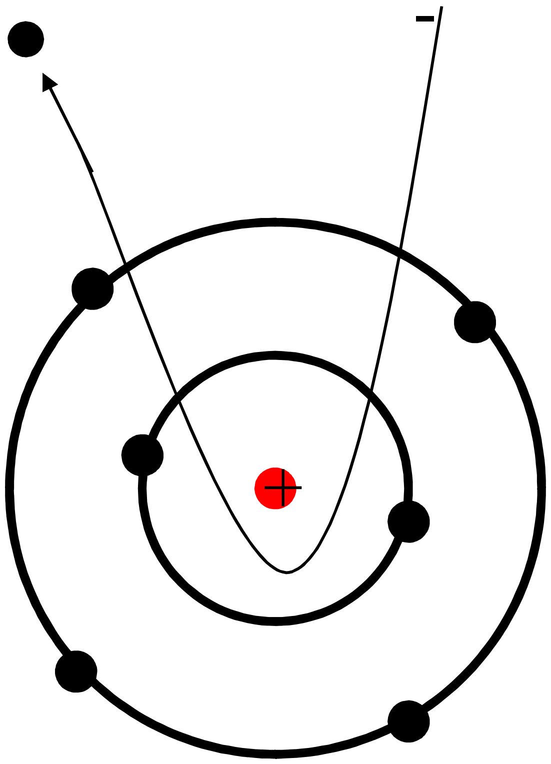
A new electron is knocked out (as a <u>secondary electron</u>)



Energy of electron from beam is lost to atom

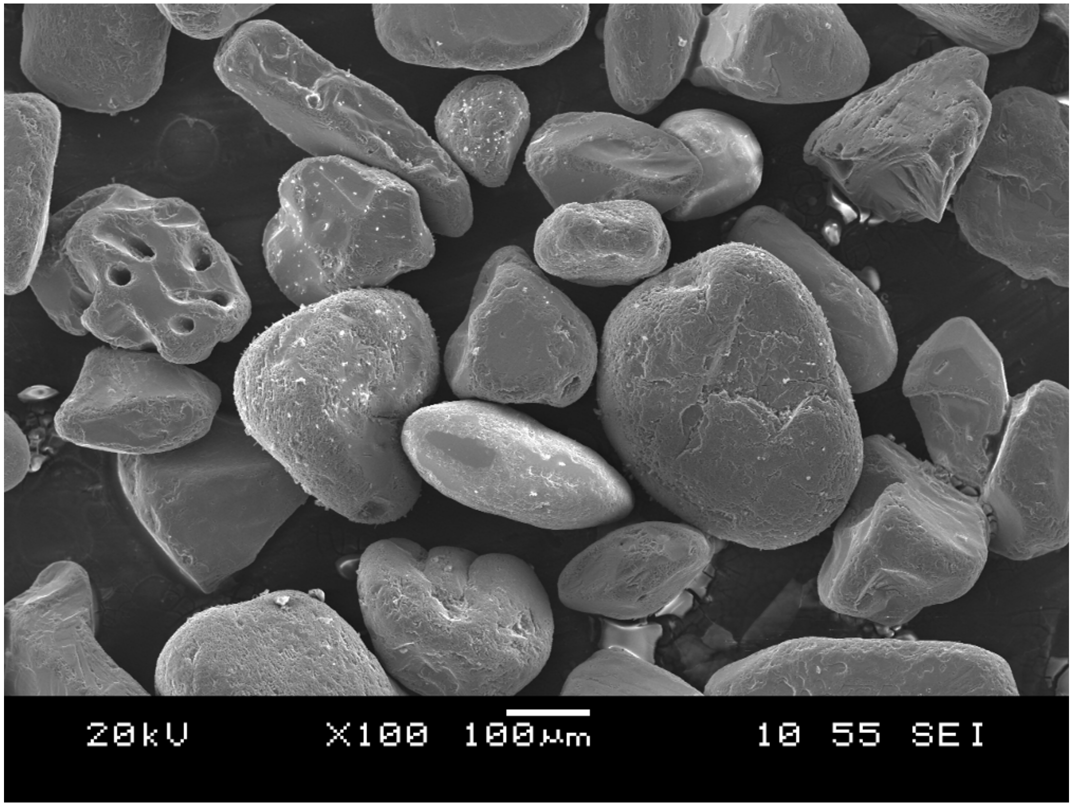
Inelastic scattering

An incoming electron rebounds back out (as a <u>backscattered electron</u>)



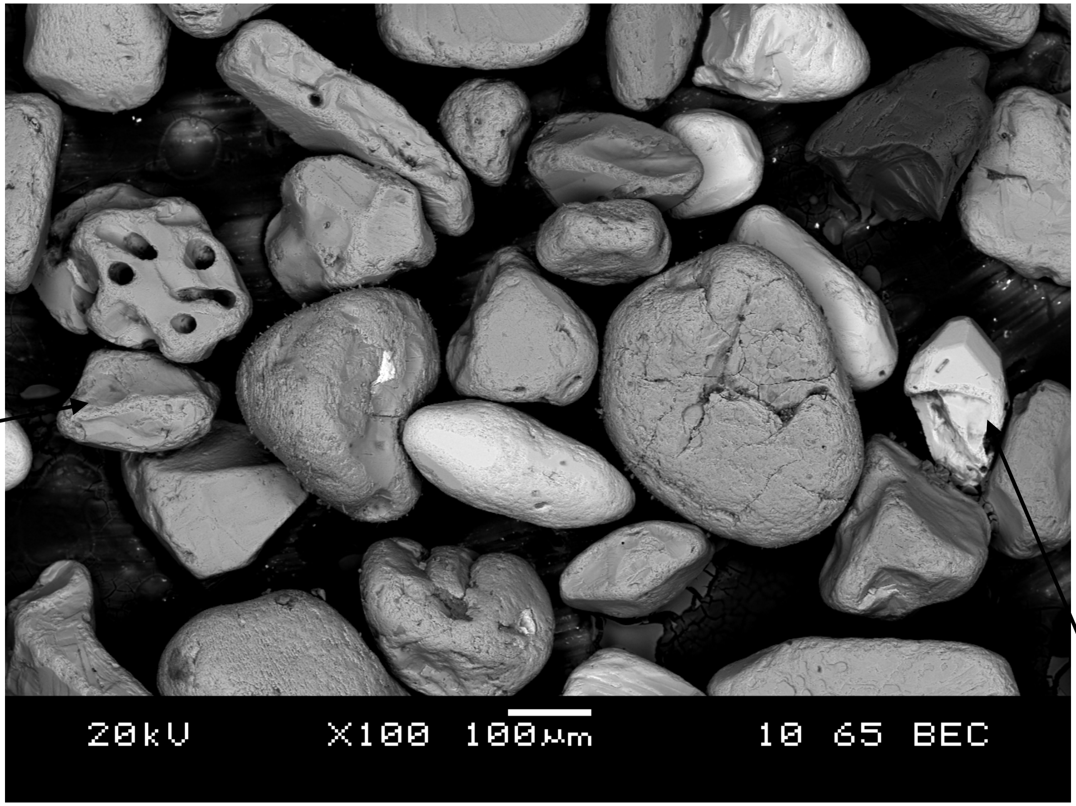
Elastic scattering

Example of an image using a scanning electron microscope and secondary electrons



Here the contrast of these grains is all quite similar.
We get a three-dimensional image of the surfaces.

Example of an image using a scanning electron microscope and <u>backscattered electrons</u>



Grain containing of silica so it is darker

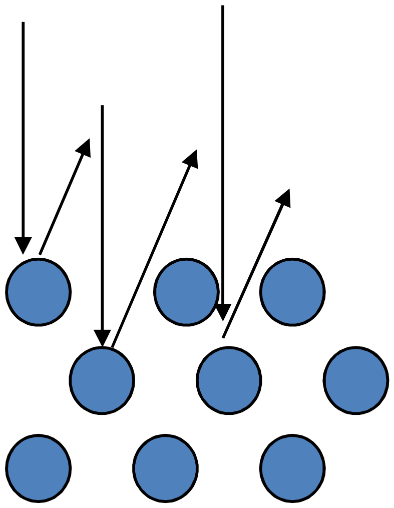
Grain containing titanium so it is whiter

Here the differing contrast of the grains tells us about composition

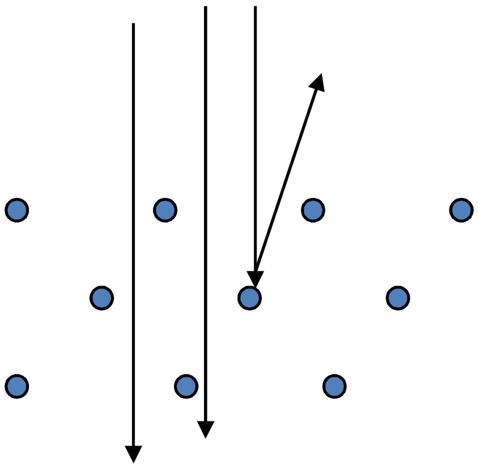
So how does this work – telling composition from **backscattered electrons**?

The higher the atomic number of the atoms the more backscattered electrons are ‘bounced back’ out

This makes the image brighter for the larger atoms

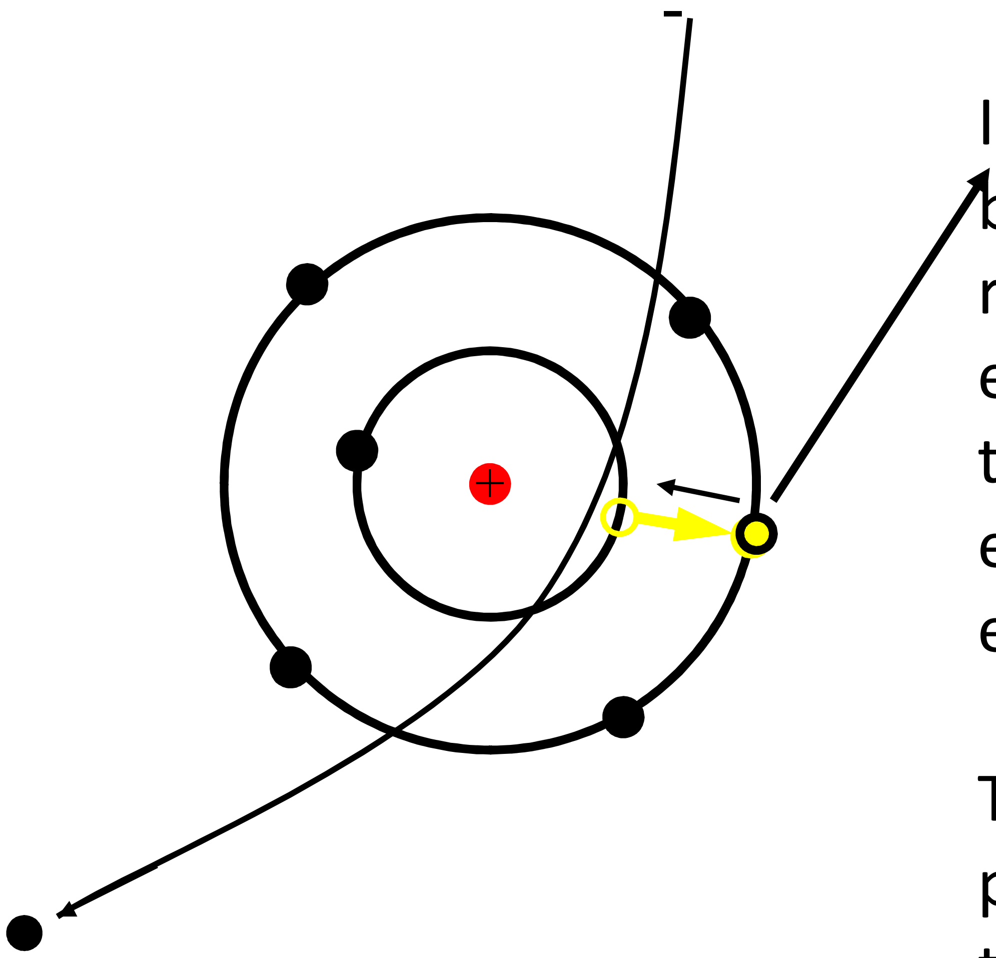


Titanium – Atomic Number 22



Silica – Atomic Number 14

Understanding compositional analysis <u>using X-rays</u> and the scanning electron microscope

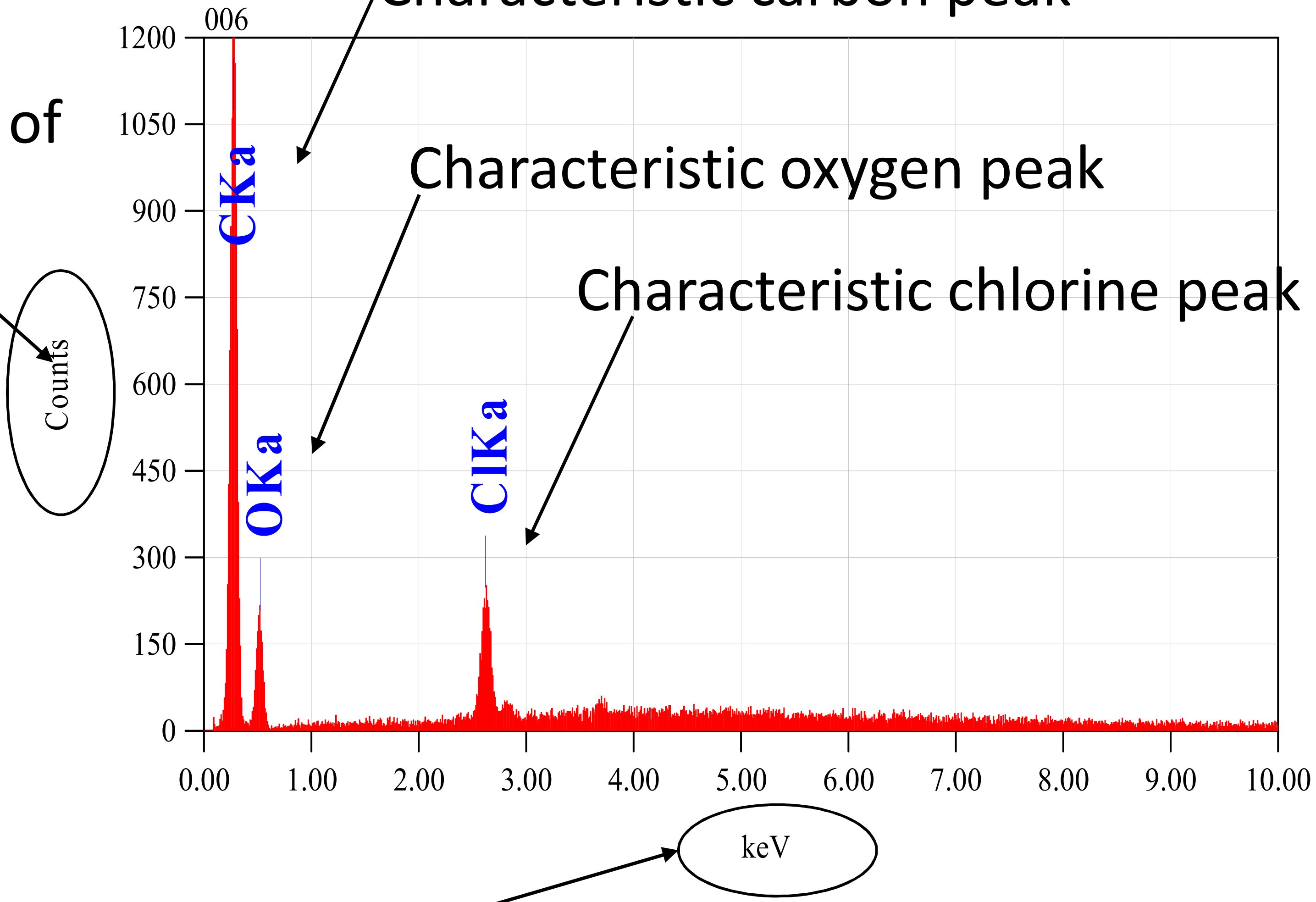


Inelastic scattering

If the yellow electron falls back again to the inner ring, that is to a lower energy state or valence, then a burst of X-ray energy is given off that equals this loss.

This is a characteristic packet of energy and can tell us what element we are dealing with

EDS output from X-rays



Characteristic carbon peak

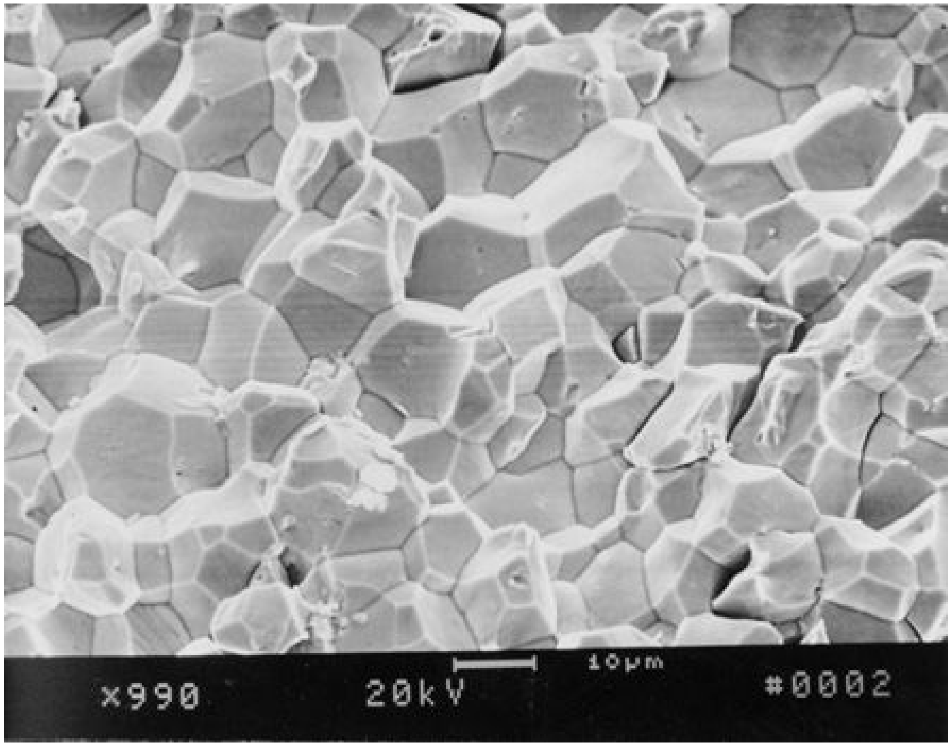
Characteristic oxygen peak

Characteristic chlorine peak

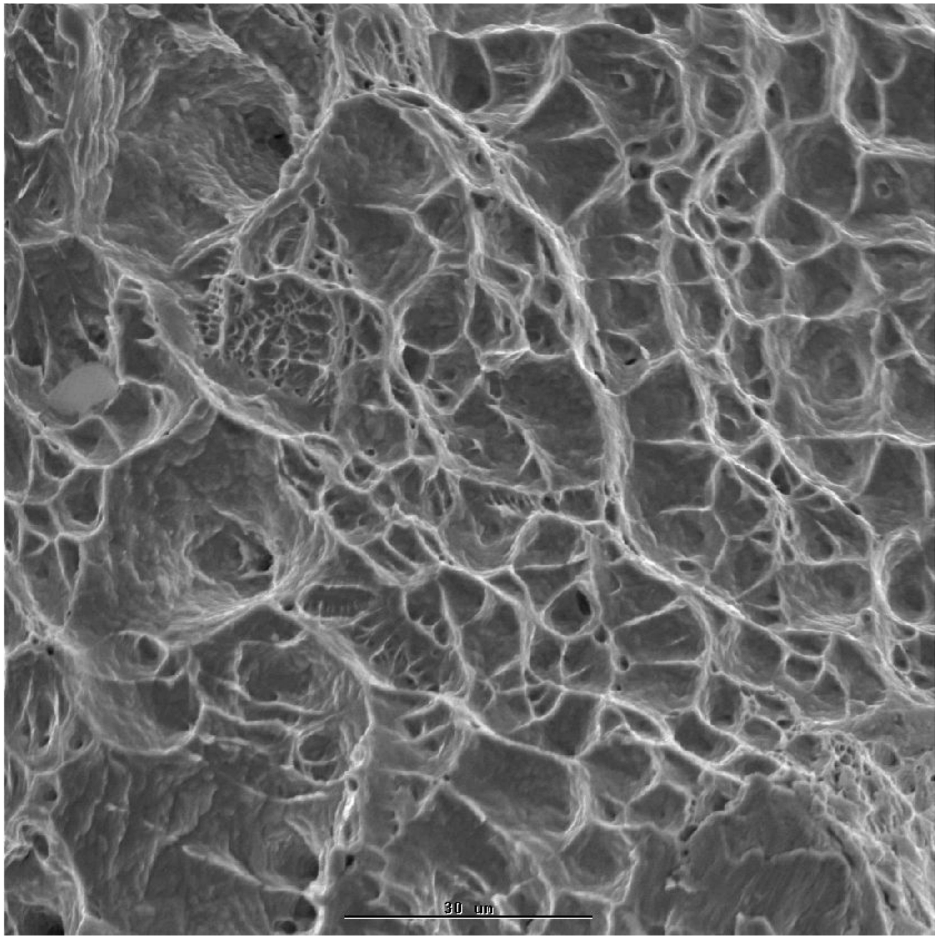
Amount of packets

Energy of packets
in thousands of electron volts

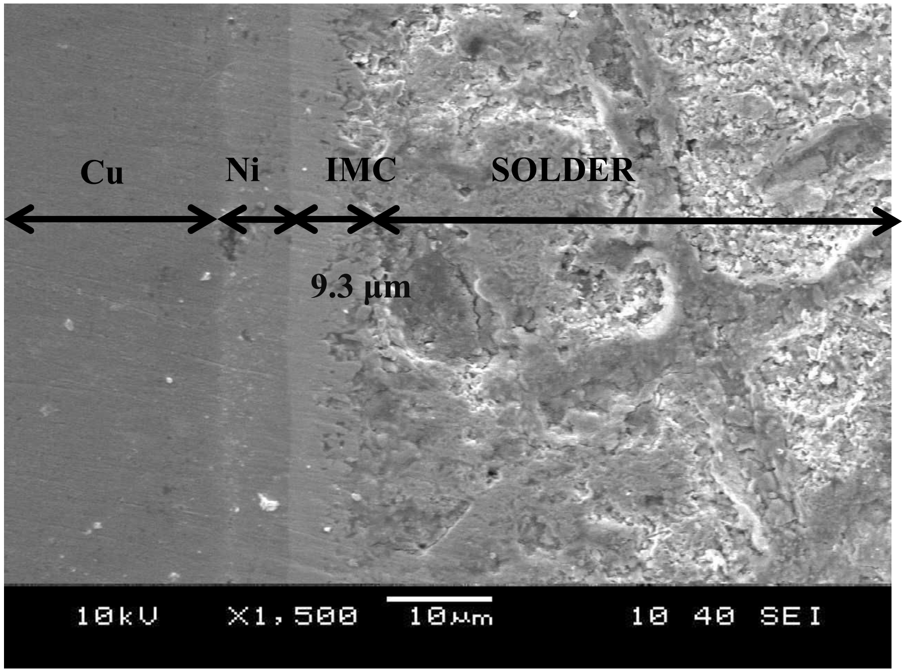
CONTOH PENGGUNAAN SEM



Intergranular fracture of steel plate

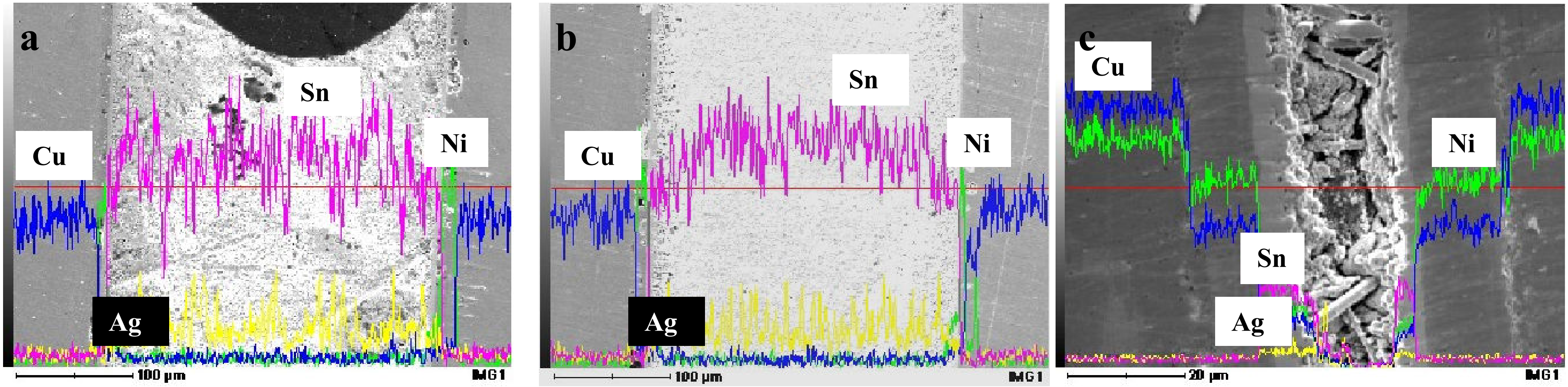


Effect of Barrier Layer and Soldering Temperature On Reliability of $SnAg_3Cu_{0.5}$ Solder Joint

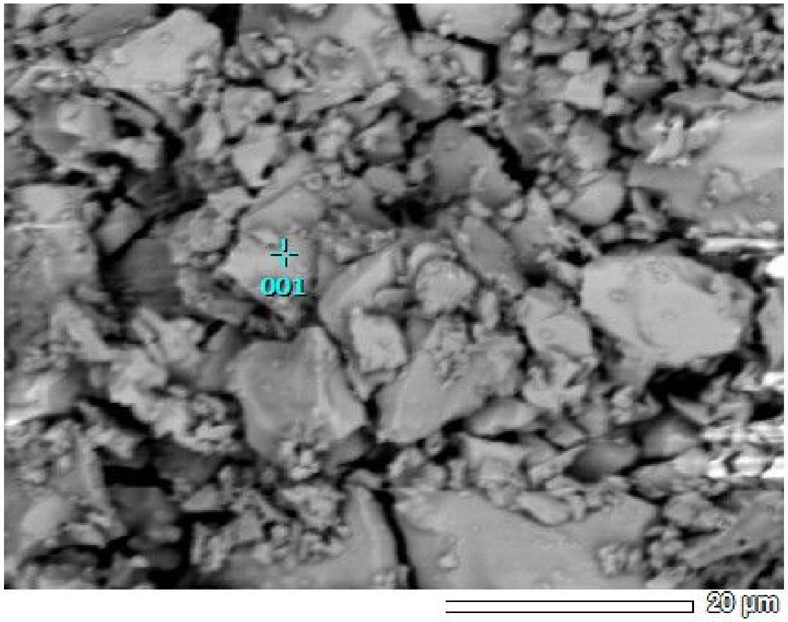


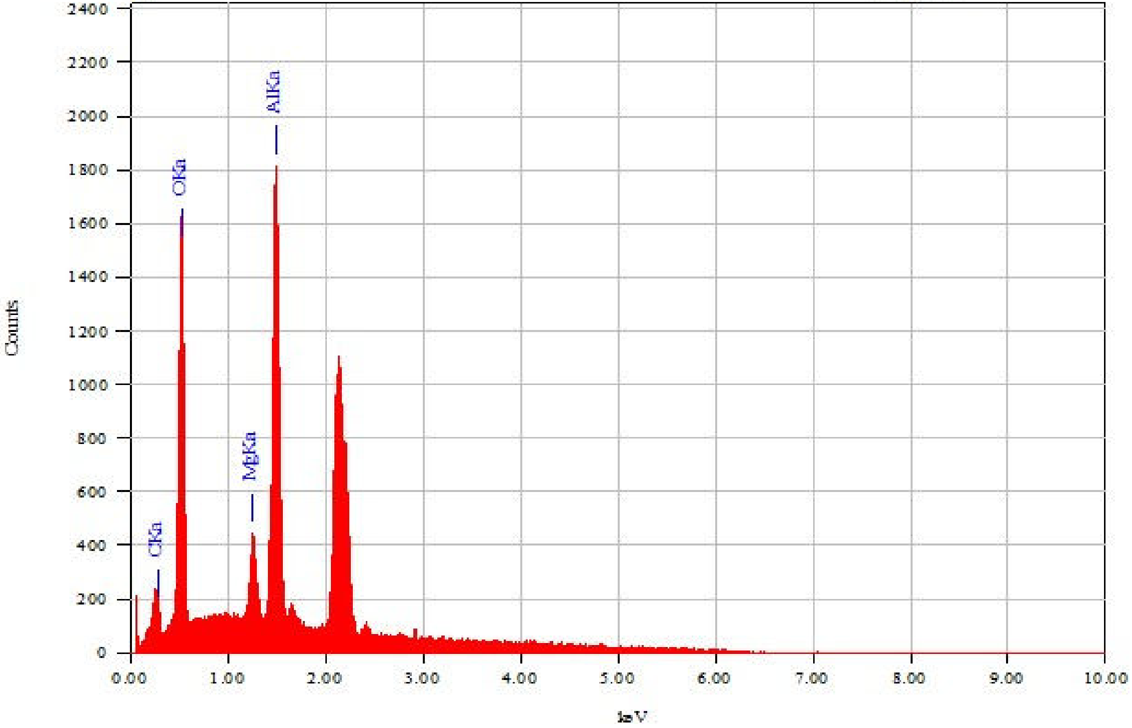
After RATIH AYU NOVITASARI

EDS observation



Refraktori Al_2O_3-MgO-C

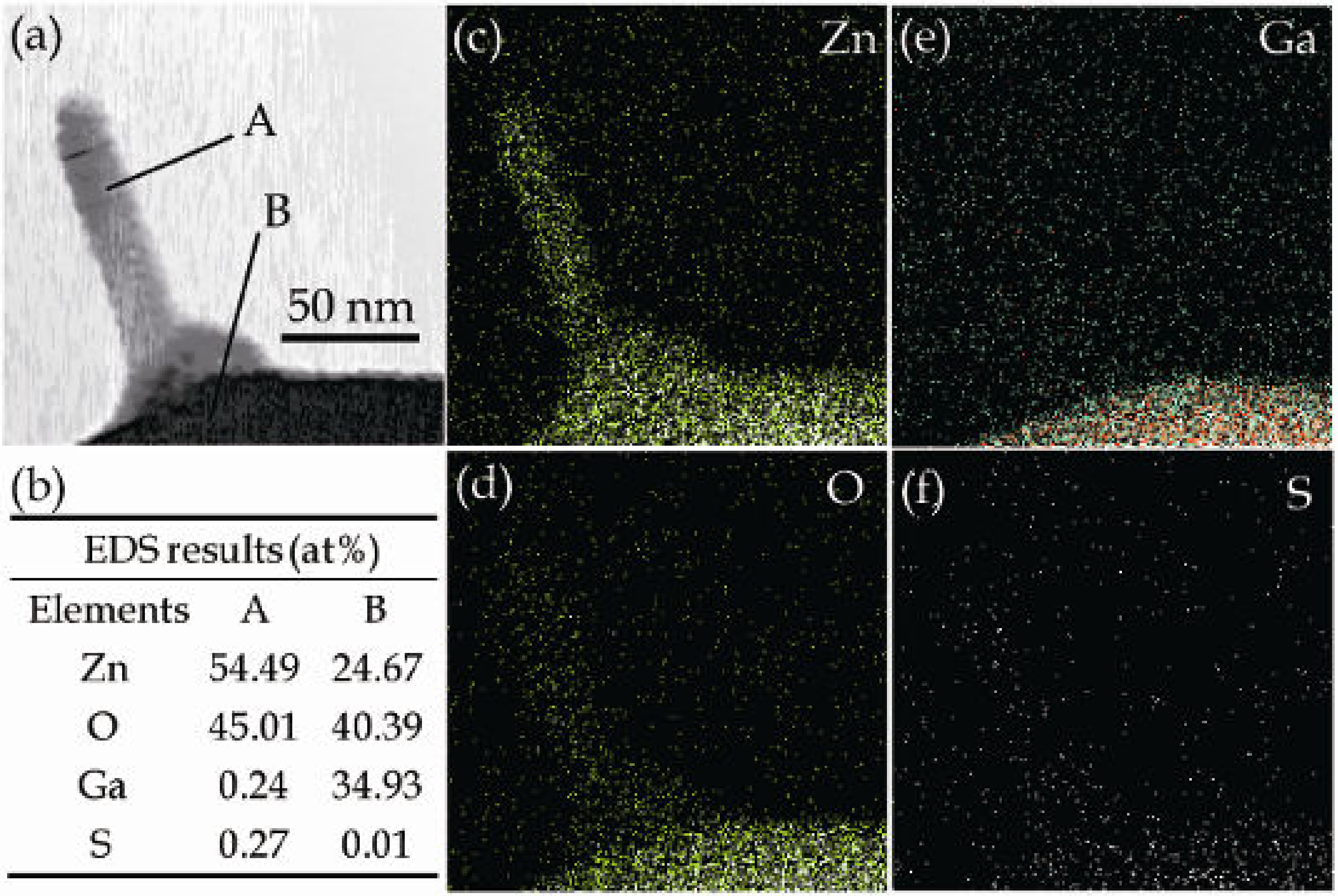




Element	(keV)	Mass%	Error%	Mol%	Compound	Mass%	Cation	K
C K	0.277	22.05	0.98	67.22	C	22.05	0.00	14.83
O		36.05						
Mg K	1.253	5.25	0.74	7.91	MgO	8.71	2.30	10.68
Al K	1.486	36.65	0.99	24.87	Al2O3	69.24	14.47	74.47
Total		100.00		100.00		100.00	16.77	

After Ridho Khusnul and Sergio Randy

Growth of nanowire and nanobelt-based oxides by thermal oxidation with gallium



EDS results (at%)

Elements	A	B
Zn	54.49	24.67
O	45.01	40.39
Ga	0.24	34.93
S	0.27	0.01