Backscattered Electron Detection

By
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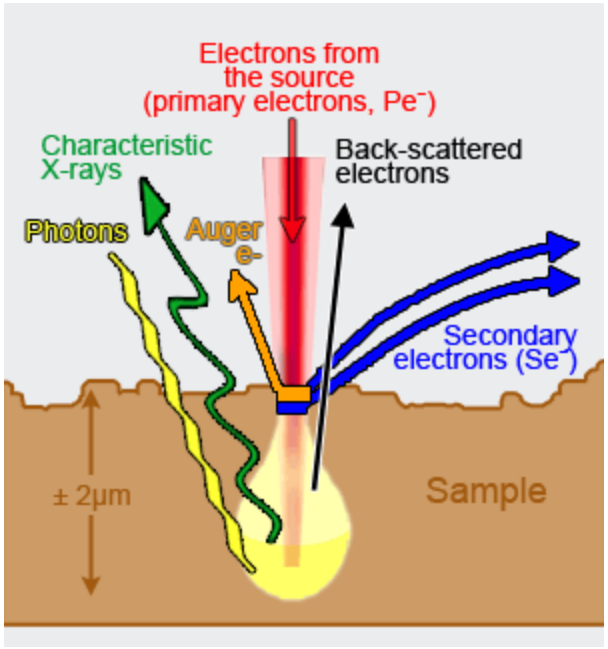
Introduction



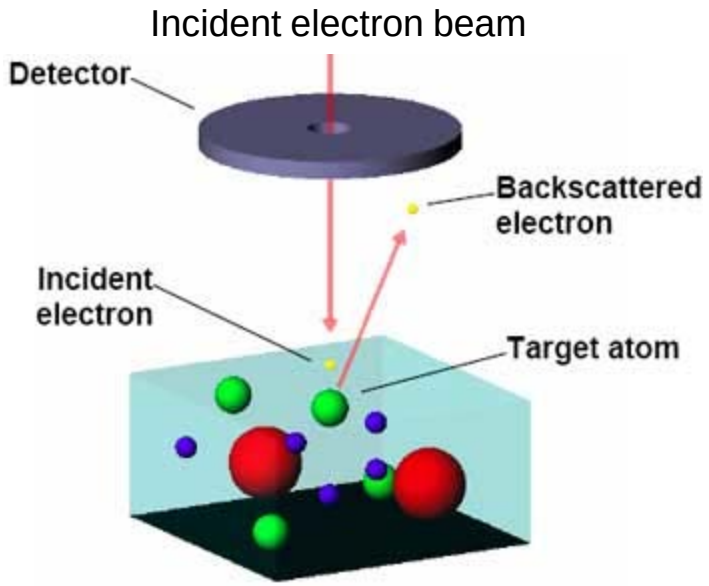
•Secondary electrons only give fine topographical information of the surface.

•Backscattered electrons give compositional information of the sample.

Generation of Backscattered electron

- High energy electrons, after interacting with the atoms in the specimen, fly back into vacuum-

Backscattered Electrons.



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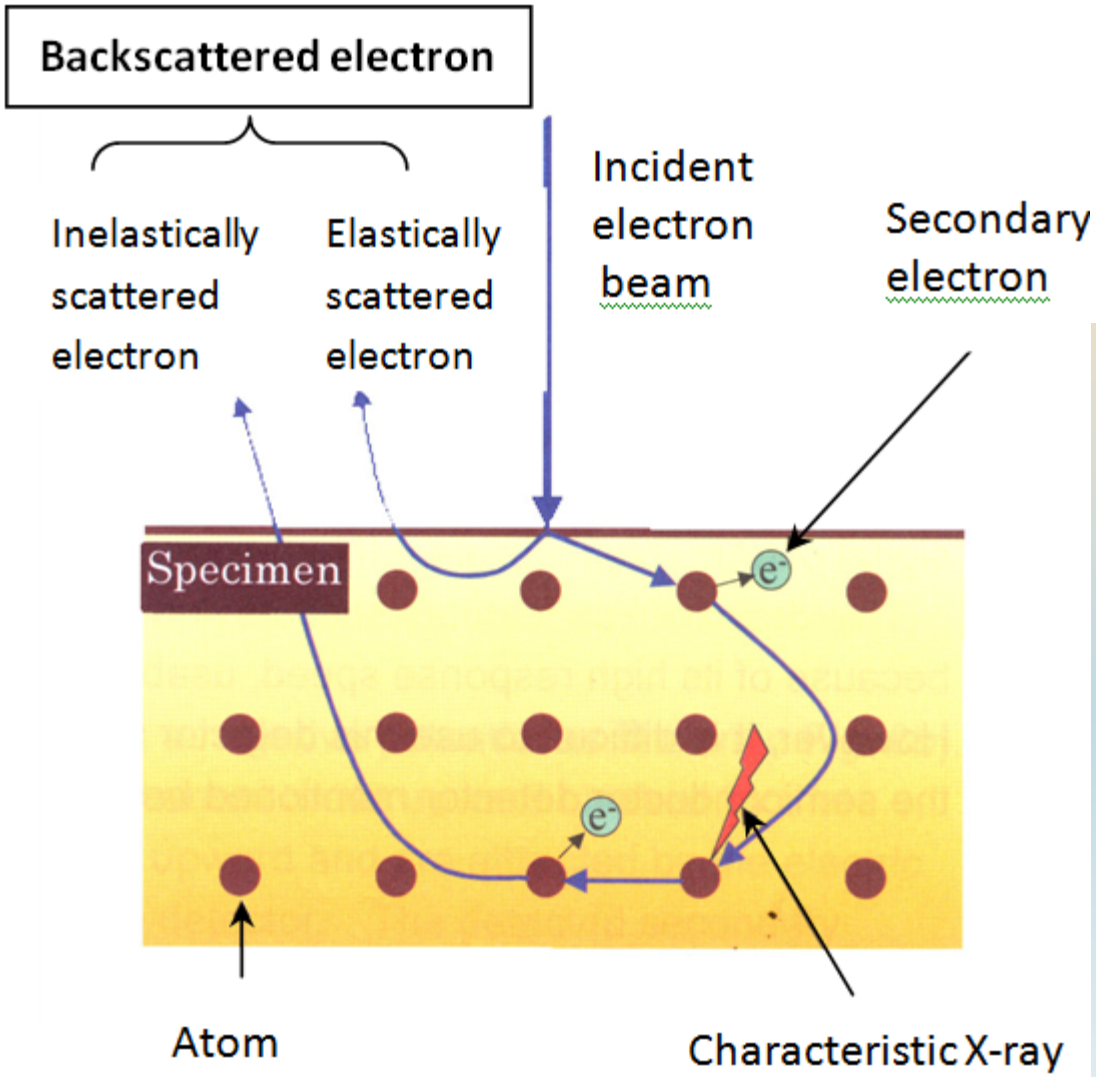

Backscattered electrons are two types:

•Elastically Scattered—
No energy loss, large scattering angle.

•Inelastically Scattered—
Loss of energy, scattered at small

Principle of imaging:

- The fraction of backscattered electrons is dependent on

Atomic number of the atoms on the Sample surface.

- Different atomic number results in different ‘Electron reflectivity’, which is given by—

$$\frac{Number\ of\ Backscattered\ electrons}{Number\ of\ incident\ electrons}$$

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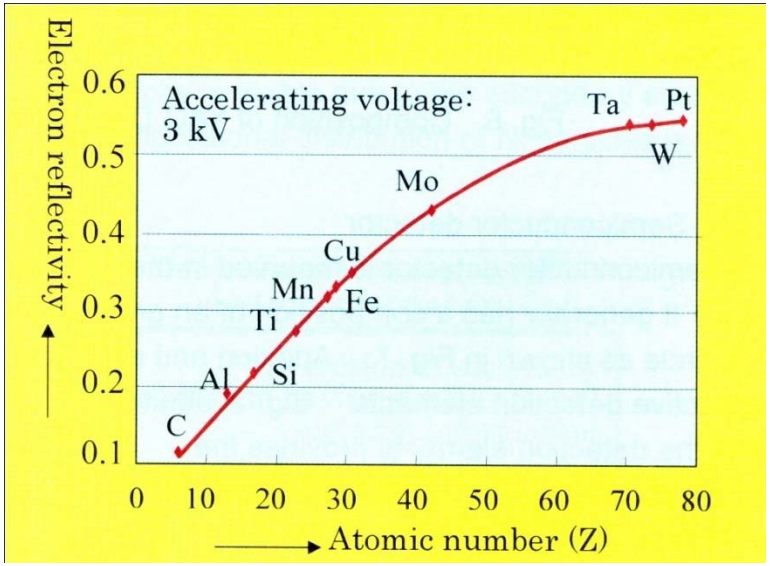
- Higher Atomic Number=Higher reflectivity.
- Backscattered electron signal covers the contrast which reflects the specimen composition.



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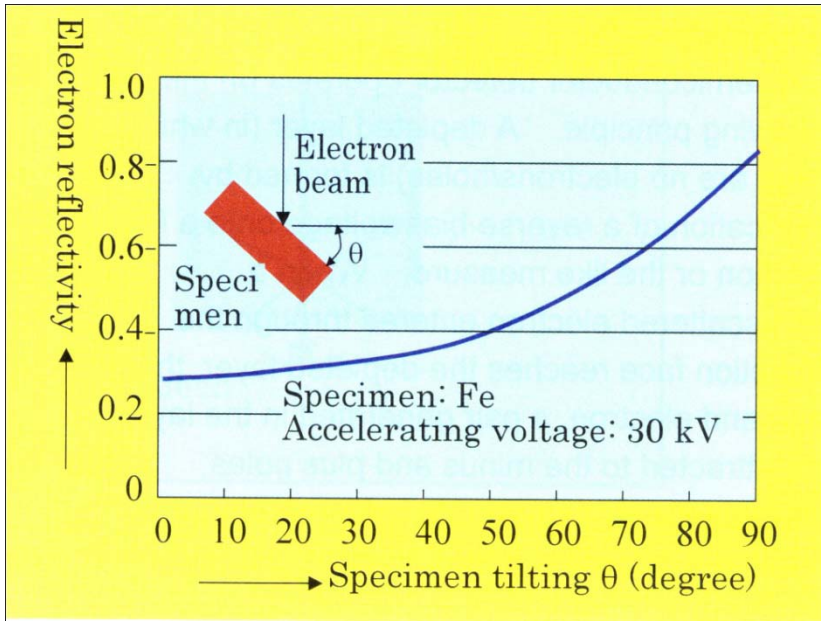
- Electron reflectivity also depends on the incident angle of electron beam .
- Reflectivity becomes larger as the specimen tilting rises. This signifies the topographic information of the specimen surface.



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- The resolution of the images is limited by the radius in which the backscattered electrons are produced.
- The radius of a hemispherical region from which backscattered electrons are produced is- $R_{BSE} \approx \frac{0.007 A E_0^{1.67}}{Z^{0.9} \rho} (\mu m)$

  A = atomic weight (gm/mol)

  Z = atomic number

  E = incident beam energy (keV)

  ρ = density (gm/cm^3)

- resolution is limited to the order of 2 x Radius, irrelevant of the diameter of the incident electron beam.

Backscattered electron detector

- The most popular kind of backscatter electron detector is the semiconductor detector.

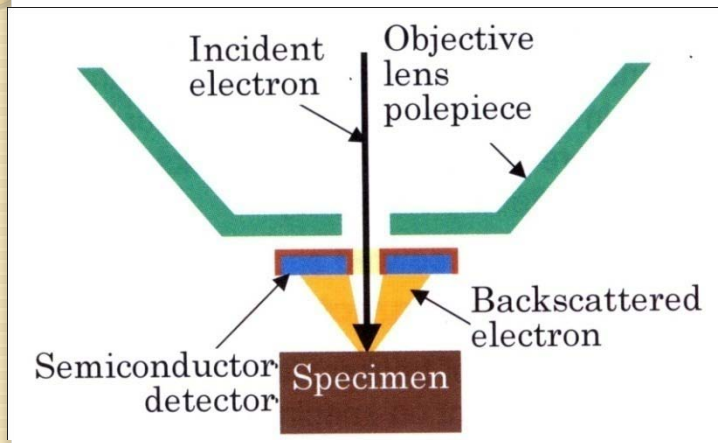


Fig: Geometry of how backscattered detector is mounted in SEM

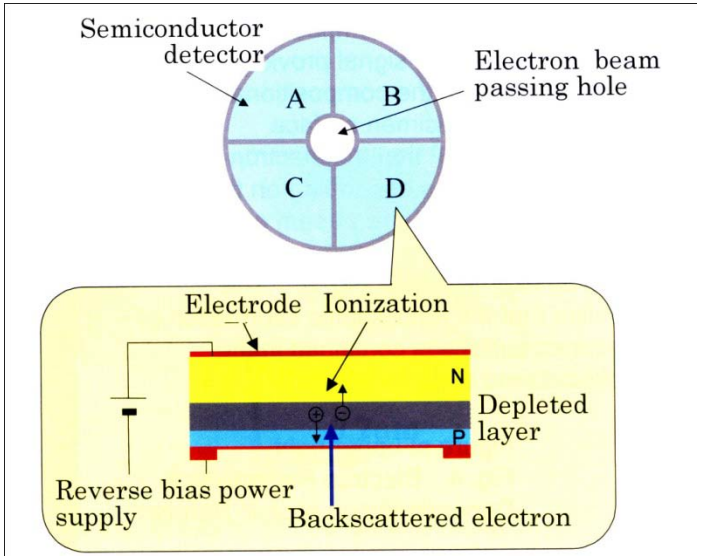
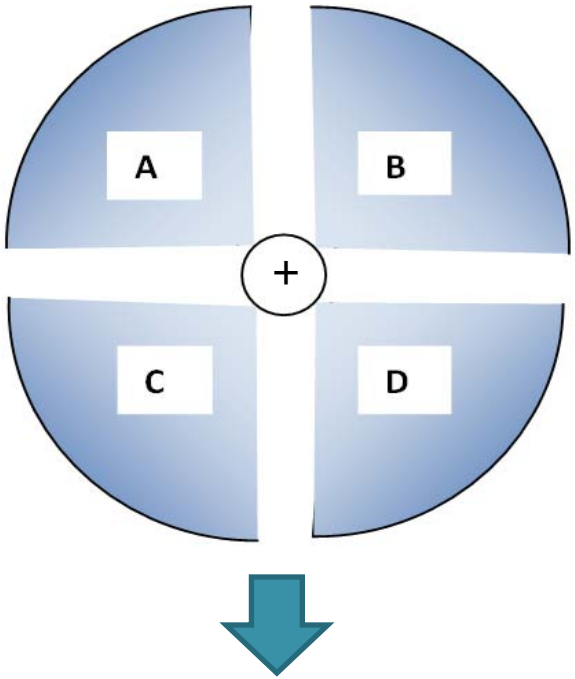


Fig: Priciple and composition of semiconductor detector

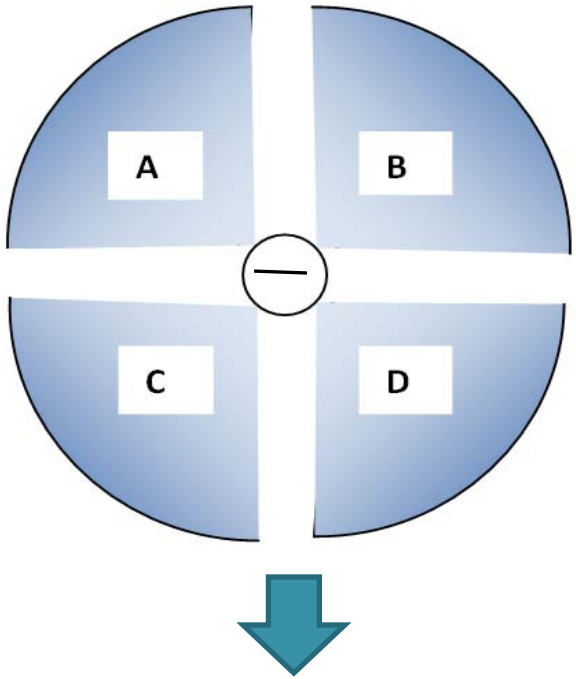
•When a backscattered electron enter into the depletion region a pair of hole and electron is generated.
•This electron hole pair is then attracted by the reverse bias. Resulting in current flow.

Backscattered electron detector

- Addition and subtraction is allowed between the signals of all the annular detection elements.



Compositional Information



Topographical Information

Images

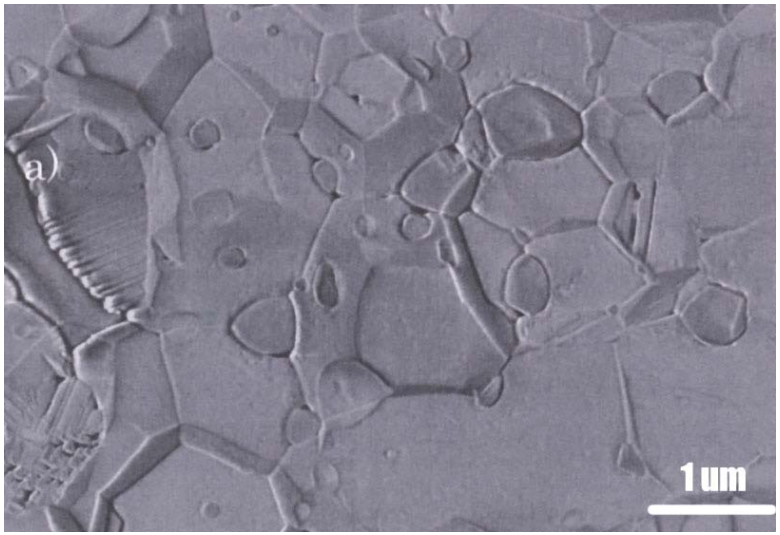


Fig: SE image of Ceramic

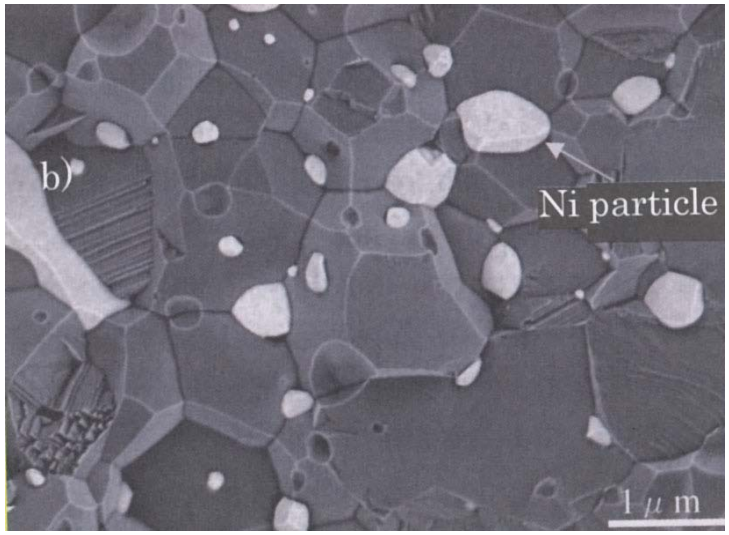


Fig: BSE image of Ceramic

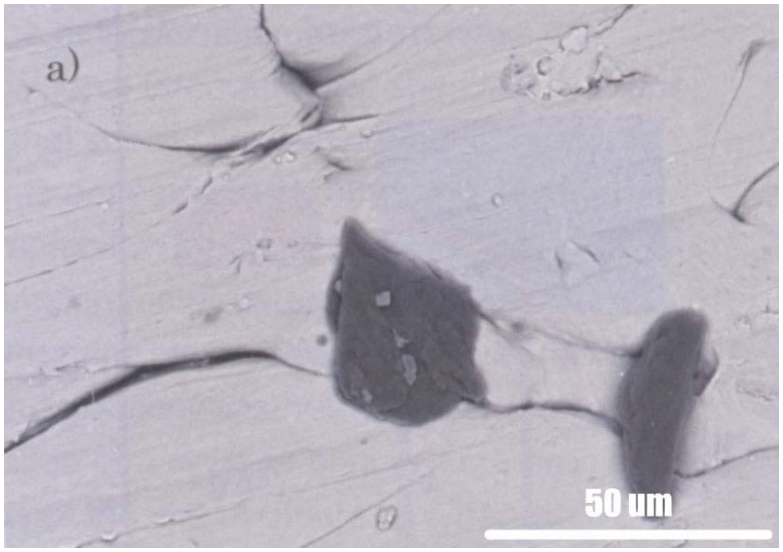


Fig: Signal added image (GMR)

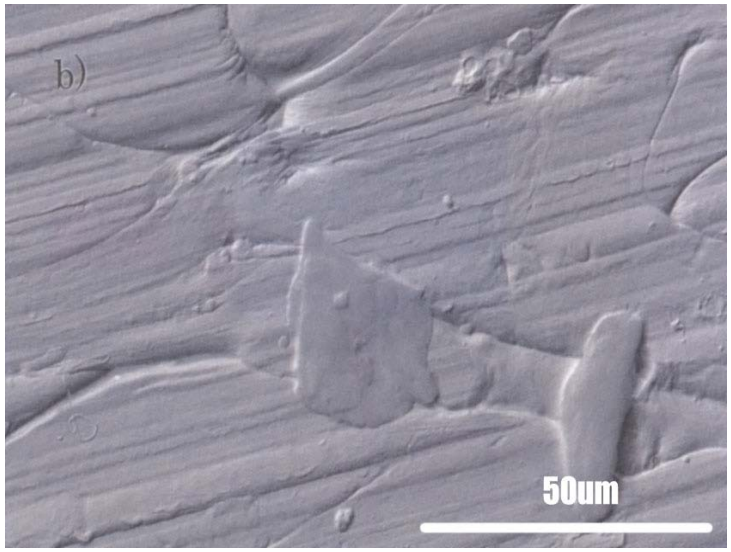


Fig: Signal subtracted image (GMR)

Application of BSE imaging:

- Medical (human bone biopsies)
- To examine the crystallographic orientation in photonic crystals.
- To examine geological and oceanographic elements……..etc.

Thank you