Electron Microscopy Technique

Introduction

Electron microscopy is scientific instruments that use a beam of highly electrons to examine objects on a very fine scale. The main advantage of the Electron Microscopy is the unusual short wave length of the electron beam compare to light energy. The wave length of about 0.005 nm increases the resolving power of the instrument to fraction of a nanometer. We can get the following information from the examination.

Topography

The surface feature of an object or how it looks its texture, the material properties like hardness reflectivity depend upon this property.

Morphology

The shape and size of the particle making up the object, direct relation between these structure and material properties like ductility, strength and reactivity etc..

Composition

The element and compound that the object is composed of and the relative amount of them, direct relationship between composition and material properties melting point hardness reactivity etc…

Crystallographic Information

How the atoms are arranged in the object, the direct relation between these arrangement and material properties mainly the electrical property.

Types of Electron Microscope

There are two main electron microscopy technique

1. Transmission electron microscopy.
2. Scanning electron microscopy.

Transmission electron microscope (TEM)

Working concept

TEM works like a slide projector, a projector shines a beam of light through the slide, as the light pass through it is affected by the structure and object on the slide. These effects result in only certain parts of the light beam transmitted through certain part of the slide. The transmitted beam is then projected onto the view screen forming an enlarge image of the slide. TEM works the same way except that they shine a beam of electrons the specimen. Whatever part is transmitted is projected onto a phosphors screen for the user. TEM working as follow for more technical explanation.

1. The electron source at the top represents the electron gun, producing a stream of monochromatic electron.
2. This stream of electron is focused to small coherent beam by the use of condenser lenses 1 and 2.
3. The beam is restricted by the condenser aperture to knock out the higher angle electron.
4. The beam strikes the specimen and part of it are transmitted.
5. This transmitted portion is focused by the objective lens in to an image.
6. The image is pass down the column through the projector lenses, being enlarge all the way.
7. The image strike the phosphor image screen and light is generated allow the user to see the image.

Specimen interaction and utilization

1. Unscattered Electron

Source: Incident electron which are transmitted through the thin specimen without any interaction occurring inside the specimen**.**

Utilization: The transmission of unscattered electron is inversely proportional to the specimen thickness. Area of the specimen that are thicker will have fewer transmitted unscattered electrons

so will appear dark, on the other hand thinner area will have more transmitted electrons and thus screen will appear brighter.

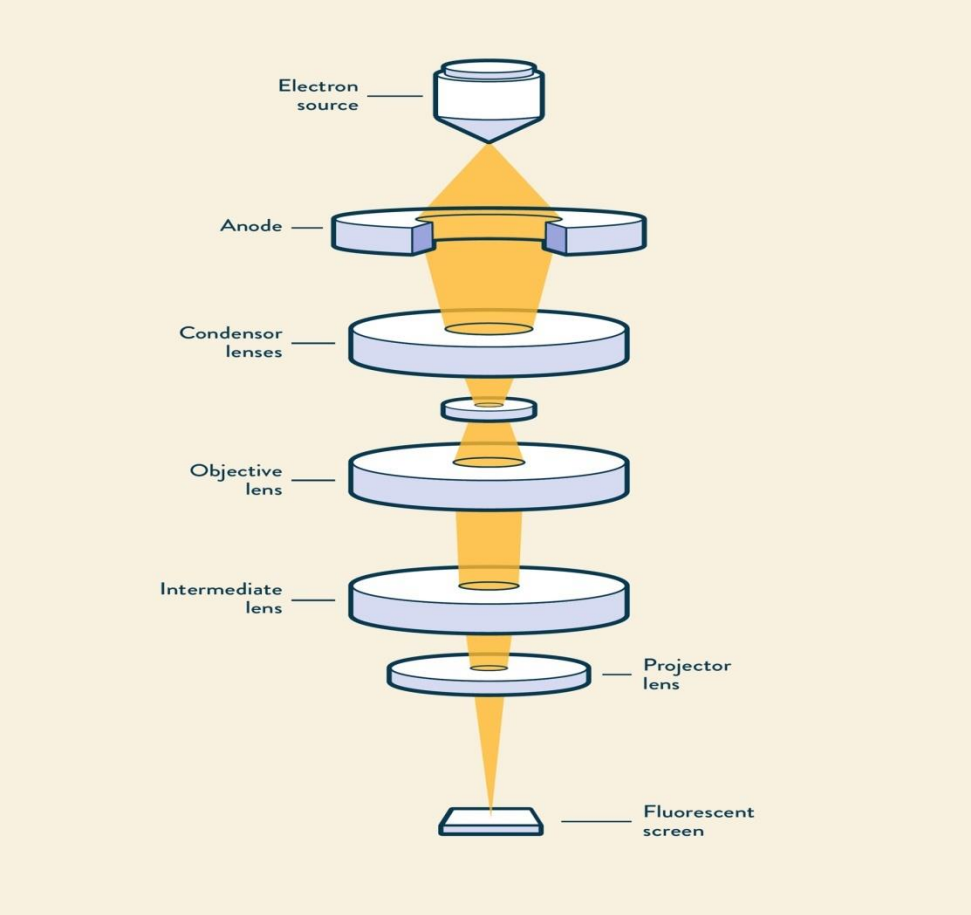

Fig. Working concept of TEM

2.Elastically scattered electron

Source: Incident electron that are scattered by atoms in the specimen in an elastic fashion (no loss of energy)

Utilization: All electron follow Bragg's law and thus are scattered according to $2d\sin\theta = n\lambda$. all incidents electron that are scattered by the same atomic spacing will scattered by the same angle.

The similar angle scattered electron can be collected using magnetic lenses to form a pattern of spots, each space corresponding to a specific atomic spacing. This pattern gives us information about the orientation atomic arrangement and phase present in the area being examined.

3.Inelatically Scattered Electron

Source Incident electron that interact with specimen atoms in a inelastic fashion loosing energy during the interaction.

Utilization

1. **Electron energy loss spectroscopy:** The inelastic loss of energy by the incident electron is characteristic of the element that was interacting with. These energy are unique each bonding state of each element and thus can be used to extract both composition and bonding information of the specimen.
2. **Kakuchi Bands: Bands of alternating:**light and dark lines that are formed by inelastic scattering interaction that are related to atomic spacing in the specimen. The width of these bands inversely proportional to atomic spacing.