**ANA 402 ASSIGNMENT**

**COURSE TITLE; ELECTRON MICROSCOPIC TECHNIQUES & ULTRASTRUCTURE**

**BY**

**OKEME SAMUEL UGBEDE-OJO 16/MHSO1/177**

**DEPARTMENT OF HUMAN ANATOMY**

**LECTURER; Dr.OGEDENGBE OLUWATOSIN OLALEKAN**

History of microscopy

The imaging of materials in the broadest sense began historically with the invention of the light microscope by Antony van Leuwenhoek, circa 1668. In 1849, Henry Clifton Sorby was the first to examine thin sections of rocks and minerals by light transmission microscopy, founding the characterization area of microscopical petrology. Fourteen years later (in 1863), Sorby was the first to examine a catastrophic failure (broken rail in a railway accident) using a light (optical) microscope, founding the field of microscopic metallurgy; the precursor of metallography and modern materials characterization (Hendwick D., *et al* 1967). Around the same time (circa 1869) cathode rays were produced by electrification of a rarefied gas and made visible by luminescence and fluorescence. These cathode rays, proposed to be negatively charged particles by Sir W. Crookes in 1886, were also observed to be deflected by both electric and magnetic fields. In 1895, J. Perrin proved that cathode rays were negatively charged particles and Roentgen discovered that X-rays were emitted when cathode rays bombarded a positively charged metal target. Shortly thereafter, X-rays were shown to reveal the macroscopic structure of internal matter. In the two decades following the turn of the twentieth century, cathode ray particles were referred to as electrons and both their charge and mass were measured. Simultaneously during this period W. H. Bragg and M. von Laue demonstrated the diffraction of X-rays from crystalline materials and illustrated their wave-particle dualism. In 1927, C. J. Davisson and L. H. Germer, simultaneously with G. P. Thomson and A. Reid, demonstrated diffraction of electrons: the former (Davisson and Germer) by electron reflection from the surface of nickel single crystals and the latter (Thomson and Reid) by passing an electron beam through celluloid and metal films. In 1933, E. Brüche demonstrated the first images of polished solid metal surfaces using photoelectrons emitted from an area irradiated with ultraviolet light. Resolutions of surface detail exceeding the light microscope by nearly an order of magnitude were obtained. Simultaneously E. Brüche and H. Johannson demonstrated the first electrostatic thermionic electron microscope consisting of a single cathode “lens” operated at a few kilovolts which projected electrons onto a fluorescent screen. In parallel with Brüche's work, M. Knoll, F. G. Houtermans and W. Schulze developed a double magnetic lens thermionic emission microscope which, along with the Brüche instruments, was the forerunner of the transmission and scanning electron microscopes (TEM and SEM respectively). Thermionic electron emission microscopes allowed metal and alloy microstructures to be observed even as grain and phase structures were nucleating and growing (Grube WL., *et al* 1980).

In 1936, E. W. Müller invented the field-electron emission microscope (FEM) which, like the thermionic electron emission microscope allowed work function contrast images to be obtained, but at much higher magnification, from a pointed metal wire specimen. In this imaging device, a high voltage is applied between the wire-cathode emitter and a conductive phospher screen. Electrons emitted by both thermionic emission and high electric field emission (thermal-field emission) are projected onto the positively charged phosphor screen; in a vacuum. The magnification of the tip is approximately given by dividing its distance from the phosphor screen by its radius of curvature. So for distances in cm and tip radii in the micron or submicron range, magnifications greater than 10,000 times could be obtained. Small crystallographic zones on the surface of an etched single-crystal metal wire could be observed by work-function contrast: different projection intensities of electrons on the phosphor screen.

Difference between Electron Microscope and Light Microscope

|  |  |
| --- | --- |
| Light Microscope | Electron Microscope |
| Uses light ( approx 400-700 nm) as an illuminating source | Uses electron beams (approx 1 nm) as an illuminating source. |
| Lower magnification than an electron microscope | Higher magnification |
| No risk of radiation leakage | Risk of radiation leakage |
| Specimen preparation takes about a few minutes or an hour | Specimen preparation takes several days |
| Both live and dead specimen can be seen | Only dead and the dried specimen can be seen |
| The image formation depends upon the light absorption from the different zones of the specimen | The image formation depends upon the electron scattering |
| The image is seen through the ocular lens. No screen needed | The image is received on a zinc sulphate fluorescent screen |
| Useful magnification of 500x to 1500x | Direct magnification as high as 16000x and photographic magnification as high as 1000000 x |
| Low resolution | High resolution |
| Inexpensive and requires low maintenance cost | Expensive and high maintenance |

Differences between SEM and TEM

|  |  |
| --- | --- |
| SCANNING ELCTRON MICROSCOPE (SEM) | TRANSMISSION ELECTRON MICROSCOPE (TEM) |
| SEM is based on scattered electrons | TEM is based on transmitted electrons. |
| SEM focuses on the sample’s surface and its composition | provides the details about internal composition |
| SEM shows only the morphology of samples. | TEM can show many characteristics of the sample, such as morphology, crystallization, stress or even magnetic domains. |
| SEM. | TEM has much higher resolution |
| In SEM, picture is shown on monitor. | In TEM, pictures are shown on fluorescent screens |
| SEM also provides a 3-dimensional image | TEM provides a 2-dimensional picture |

References

Grube WL, Rouze SR. Thermionic emission microscopy – Applications in High-Temperature-High Resolution Metallography. New York: Gordon and Breach Science Publishers, Inc.; 1967. p. 47–69

Hendwick D, Williams WM. The birth of metallography. The work of Henry Clifton Sorby (1826–1908). Bull Canad Inst Mining & Metallurgy 1980;73(813):143–4.