Electron microscopy Assignment

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16/MHS03/001

**The history of the microscopy**

The general principles of reflection with some idea of the refraction of light, and notably the optical properties of curved mirrors, were comprehended by Euclid (or at least by a writer using his name) in the third century B.C. as well as by the mathematician Ptolemy, in the second century A.D. The knowledge of these writers was handed on to mediaeval Europe by the Arab, Alhazen (died 1038), who developed the ideas of his predecessors as applied to curved mirrors in considerable detail and with great mathematical skill. Alhazen was aware of the action of reflecting surfaces, formed by the rotation of a conic section, and he was, therefore, able accurately to project magnified images.' His work was familiar to at least two thirteenth century writers on optics, Vitello who attempted to use segments of glass balls to get a better view of small objects, and Roger Bacon, who had a clear conception of the simple microscope and of the possibility of bringing distant objects near and of indefinitely magnifying minute objects, by giving suitable direction to refracted rays and by the use of appropriate media.2 In Europe the invention of convex glasses for use as spectacles is attributed to Salvino d'Amarto degli Armati, of Florence, and to Alessandro de Spina, of Pisa, about the year 1300.3 The first mention of these instruments is, however, said to be by Bernard de Gordon (died c. 1307) in his "Lilium Medicinae.

In the sixteenth century, curiosity in scientific matters began to assert itself. That universal genius, Leonardo da Vinci (1452-1519), had already investigated some of the effects of concave, as well as of convex, glasses,1 while those interested in alchemy frequently used flasks filled with water, concave mirrors or else glass balls to concentrate rays of the sun.2 Moreover, some of the optical properties of lenses were enunciated by Maurolico3 (1494-1575), and later by Kepler4 (1571-1630). Long before the dawn of the seventeenth century the principle of the lens was both comprehended and applied to scientific matters by the Englishmen, Leonard Digges and his son Thomas, and by the Italian, Giambattista Porta.

**The history of the electron microscope**

In 1926 Hans Busch developed the electromagnetic lens.

According to Dennis Gabor, the physicist Leó Szilárd tried in 1928 to convince him to build an electron microscope, for which he had ﬁled a patent. The ﬁrst prototype electron microscope, capable of four hundred-power magniﬁcation, was developed in 1931 by the physicist Ernst Ruska and the electrical engineer Max Knoll. The apparatus was the ﬁrst practical demonstration of the principles of electron microscopy. In May of the same year, Reinhold Rudenberg, the scientiﬁc director of Siemens

Schuckertwerke, obtained a patent for an electron microscope. In 1932, Ernst Lubcke of Siemens & Halske built and obtained images from a prototype electron microscope, applying the concepts described in Rudenberg's patent.

In the following year, 1933, Ruska built the ﬁrst electron microscope that exceeded the resolution attainable with an optical (light) microscope. Four years later, in 1937, Siemens ﬁnanced the work of Ernst Ruska and Bodo von Borries, and employed Helmut Ruska, Ernst's brother, to develop applications for the microscope, especially with biological specimens.

Also in 1937, Manfred von Ardenne pioneered the scanning electron microscope. Siemens produced the ﬁrst commercial electron microscope in 1938. The ﬁrst North American electron microscope was constructed in 1938, at the University of Toronto, by Eli Franklin Burton and students Cecil Hall, James Hillier, and Albert Prebus. Siemens produced a transmission electron microscope (TEM) in 1939. Although current transmission electron microscopes are capable of two million power magniﬁcation, as scientiﬁc instruments, they remain based upon Ruska’s prototype.

**Difference between the light microscope and the electron microscope**

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| No | Basis for comparison | | Light Microscope | Electron Microscope |
| 1 | Source to view the object | | Visible light source | Beam of charged particles i.e. electrons |
| 2 | Lenses used | | Glass lenses | Electromagnetic lenses |
| 3 | Magnification | | 1000X | 10,00,000X |
| 4 | Resolving power | | 0.2um | 0.5nm |
| 5 | Screen | | Projection screen | Fluorescent screen |
| 6 | Voltage | | No need of high voltage electricity | High voltage electric current is required (around 50000 volts and above |
| 7 | Cooling system | | There is no requirement for high cooling system | It has a high cooling system in order to move out the heat generated by high voltage electric current |
| 9 | | Filament | No filament | Tungsten filament is used |
| 10 | | Radiation leakage | No radiation risk | There is risk of radiation leakage |

**Difference between SEM and TEM**

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| SEM | TEM |
| SEM is based on scattered electrons. | TEM is based on transmitted electrons. |
| The scattered electrons in SEM produced the image of the sample after the microscope collects and counts the scattered electrons. | In TEM electrons are directly pointed towards the sample. |
| SEM focuses on sample surface and its composition. | TEM seeks to see what is inside or beyond the surface. |
| SEM shows the sample bit by bit. | TEM shows the sample as a whole. |
| SEM provides a 3-dimesional image. | TEM provides a 2-dimensional image. |
| SEM only offers 2 million as a maximum level of magnification. | TEM has up to a 50 million magnification. |
| SEM has a 0.4 nanometers. | The resolution of TEM is 0.5 angstroms. |