

# Electron Microscopy Market in India

- T. Sai Kamaraju

The first electron microscope prototype was built in 1931 by the German engineers Ernst Ruska and Max Knoll. It was based on the ideas and discoveries of French physicist Louis de Broglie. Although it was primitive and not fit for practical use, the instrument was still capable of magnifying objects by four hundred times.

Reinhold Rudenberg, the research director of Siemens, had patented the electron microscope in 1931, although Siemens was doing no research on electron microscopes at that time. In 1937 Siemens began funding Ruska and Bodo von Borries to develop an electron microscope. Siemens also employed Ruska's brother Helmut to work on applications, particularly with biological specimens.

In the same decade of 1930s Manfred von Ardenne pioneered the scanning electron microscope and his universal electron microscope.

Siemens produced the first commercial Transmission Electron Microscope in 1939, but the first practical electron microscope had been built at the University of Toronto in 1938, by Eli Franklin Burton and students Cecil Hall, James Hillier and Albert Prebus.

Although modern electron microscopes can magnify objects up to two million times, they are still based upon Ruska's prototype. The electron microscope is an integral part of many laboratories. Researchers use it to examine biological materials (such as microorganisms and cells), a variety of large molecules, medical biopsy samples, metals and crystalline structures, and the characteristics of various surfaces. The electron microscope is also used extensively for inspection, quality assurance and failure analysis applications in industry, including, in particular, semiconductor device fabrication.

## Market Dynamics in India

- ⇒ **The total Electron Microscopes sold in India are 800 plus systems.**
- ⇒ **Currently the market size is 60 units per year - 45 numbers are SEM and 15 numbers are TEM.**
- ⇒ **The market is from both Material Science and Biological Sciences in 70:30 ratio.**
- ⇒ **The upcoming requirement in Nano Science and Nano Technology will push the market size to 100 numbers in the coming years.**
- ⇒ **Very soon, the Electron Microscope base in India will touch a landmark of 1000 units.**

## Transmission Electron Microscope (TEM)

The original form of electron microscopy, Transmission electron microscopy (TEM) involves a high voltage electron beam emitted by a cathode, usually a tungsten filament and focused by electrostatic and electromagnetic lenses. The electron beam that has been transmitted through a specimen that is in part transparent to electrons carries information about the inner structure of the specimen in the electron beam that reaches the imaging system of the microscope. The spatial variation in this information (the "image") is then magnified by a series of electromagnetic lenses until it is recorded by hitting a fluorescent screen, photographic plate, or light sensitive sensor such as a CCD (charge-coupled device) camera. The image detected by the CCD may be displayed in real time on a monitor or computer.

Resolution of the Transmission Electron Microscope is limited primarily by spherical aberration, but a new generation of aberration correctors have been able to partially overcome spherical aberration to increase resolution. Software correction of spherical aberration for the High Resolution Transmission Electron Microscope (HRTEM) has allowed the production of

images with sufficient resolution to show carbon atoms in diamond separated by only 0.89 ångström (89 picometers) and atoms in silicon at 0.78 ångström (78 picometers) at magnifications of 50 million times. The ability to determine the positions of atoms within materials has made the HRTEM an

### T. SAI KAMARAJU



*Tetali Sai Kamaraju is the Managing Director of Forevision Instruments (I) Pvt Ltd Hyderabad. A postgraduate in Physics with specialization in electronics from Osmania University, he worked with Toshniwal Brothers (SR) Pvt Ltd for nearly 14 years and ShivaChem Technologies Hyderabad for three years before starting Forevision Instruments in 1997. For all these 25 years he was associated with Microscope product line. Sai Kamaraju is the life member of Electron Microscope Society of India and an active member of the Instrument Society of India – Hyderabad Chapter.*



important tool for nano-technologies research and development.

### Scanning Electron Microscope (SEM)

Unlike the TEM, where electrons of the high voltage beam form the image of the specimen, the Scanning Electron Microscope (SEM) produces images by detecting low energy secondary electrons which are emitted from the surface of the specimen due to excitation by the primary electron beam. In the SEM, the electron beam is rastered across the sample, with detectors building up an image by mapping the detected signals with beam position.

Generally, the TEM resolution is about an order of magnitude greater than the SEM resolution, however, because the SEM image relies on surface processes rather than transmission it is able to image bulk samples and has a much greater depth of view, and so can produce images that are a good representation of the 3D structure of the sample.

Purchasing of Electron Microscopes in India has started since more than 40 years and the initial players were Siemens & Philips followed by JEOL, Hitachi & Cambridge. All these years TEM market size is quite low comparable to SEM due to its cost, requirement and applications.

While the total Electron Microscopes sold in India is around 800 plus, it is sad to see only fifty percent of them are in working condition for various reasons while keeping aside the condemned ones.

Currently Electron Microscope market size has grown to 60 per year which has been shared almost equally by Fei (Philips), Zeiss (Cambridge/Leica/LEO), JEOL and Hitachi. There is a new comer (who entered in the market during 2005) Tescan from CZK and they sold more than 5 SEMs during last 2 years. Interestingly Suppliers like Akashi (Topcon), Camscan (Gresham) and Shimadzu did sell SEMs in India during these 30 years.

While adequate Technical & Service Support is available from all Suppliers and their Indian Agents, all EM users are expecting stock and sale of EM Consumables & Spares to reduce the downtime of EM.

Since year 2002, Department of Science & Technology of Ministry of Science and Technology of Government of India providing very good amount of funds under NSTI Program to various Scientific & Technological Institutions which has increased the market size of Electron Microscopes from 15 in year 2002 and 60 in year 2007.

Currently EM market size of 60 per year comes with around 45 SEM and 15 TEM. This market is from both Material Sciences

and Biological Sciences (Medical & Pharma) with a percentage of 70:30 respectively.

As explained above there are two types of Electron Microscopes namely TEM and SEM and in TEM there are HR-TEM for Materials Science applications with 200/300/400KV Accelerating Voltage and Bio-TEM for Biological Applications (covering Life Sciences with Medical & Pharma) with 100/120KV Accelerating Voltage

**Whereas in SEM there are various types of Models like:**

- Table Top SEM
- Entry Level SEM
- Research Level SEM
- High Resolution SEM(FE-SEM)
- Ultra High Resolution SEM(UHR-FESEM)
- Conventional STEM
- Cs Corrected STEM

Further it is quite encouraging to see that various other departments of Government of India like DBT, MIT, CSIR, MHRD, ICMR and ICAR also allotting very good amount of funds to support Nano-Science & Nano-Technology in various segments like Bio-Technology, Electronics & Semi-conductor, Education & Research, Medical and Agricultural which might increase EM market size to 100 in the coming few years.

Last few years Indian Electron Microscopy market has seen the sales of sophisticated and very powerful Equipments like FE-TEM, HR-TEM (200/300KV), FE-SEM, DualBeam (FIB+SEM/FE-SEM) and Nano Lithography Systems with SEM/FE-SEM, which really has taken Indian EM market to new heights to compete at par with U.S, Japan, Europe and other countries in Asia.

We all wish EMSI – Electron Microscope Society of India do shape up with more visibility and activities in the coming years to support Suppliers-Agents, existing users and new buyers to get updated information/details on what's happening world wide so that every one in this market is benefited.

Like other Analytical Equipment landmark sales in India, Electron Microscope sales will touch 1000 landmark in couple of years to come. ■