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Electron Microscope Room Design Considerations

Overview

Electron microscopes (EMs) use a beam of accelerated electrons as a source of illumination. Because the wavelengths of an electron are many times shorter than that of visible light photons, EMs have much higher resolution than conventional microscopes. Due to the complexity and sensitivity of EMs, the evaluation and selection of the site, room location, and environmental conditions must all be carefully considered for the EMs to achieve optimal performance.

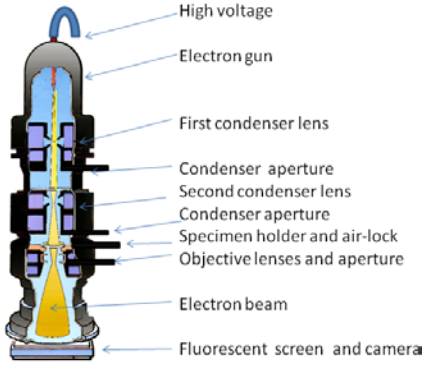

Figure 1: TEM (Transmission Electron Microscopes)

The two most common types of EMs are transmission electron microscopes (TEMs) and scanning electron microscopes (SEMs).

TEMs use very thin specimens under vacuum. Electrons travel through the specimen through a series of lenses which project the image on a fluorescent screen. See **Figure 1**.

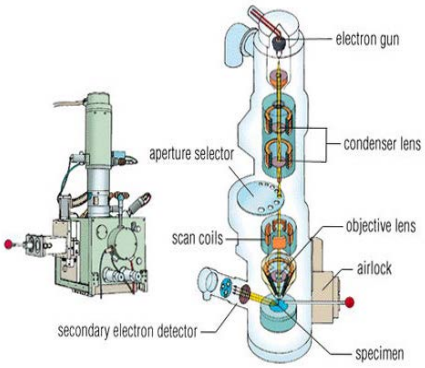

Figure 2: SEM (Scanning Electron Microscopes)

SEMs scan a specimen with a focused beam of electrons which interact with atoms in the sample, producing signals that contain information about the sample's surface topography and composition. See **Figure 2.**

Both TEMs and SEMs require samples that are maintained under a vacuum environment because a gas atmosphere rapidly spreads and attenuates the electron beam which can negatively impact the projected image.

Evaluation of the Electron Microscope Design Parameters

Due to the complexity of the design and high sensitivity of the Ems, it is important that a comprehensive evaluation of the intended location for the facility be performed. There are several factors that must be investigated to determine whether the overall environment meets the equipment operating conditions, such as vibration, noise, temperature control, pressure differentials, electrical equipment magnetic fields and radio frequency noise.

- Vibration: Vertical vibration may contribute to the spread of focus in the image and can limit the attainable resolution. Horizontal vibration will directly distort the image. Vibration can reach the EM through the floor (background vibration from vehicular traffic, movement of heavy equipment, from its own ancillary equipment), through the HVAC system (acoustic vibration), footfalls and other sources. Some of the vibration may be coming from the building's natural frequency.
- Noise: The impact of noise in EMs may be from residual noise sources from alternating current fields or HVAC sources.
- Temperature Control: The removal of heat from an EM room requires air devices that may produce noise and drafty conditions that should be avoided.
- Pressure Differential: Significant pressure differential impacting the EM room can cause variations in the vacuum chamber and its controls.
- Magnetic Field: Alternating-current electromagnetic interference (AC-EMI) is a common source of scan noise. Determining whether the observed noise is from EMI or coupled through vibrations or acoustics is required.
- Radio Frequencies Noise: Although electron microscopes may be designed to shield radio frequency noise, they may not be very effective with frequencies of 3000 Hz or lower.

Conclusion

The impact of the design parameters listed above may negatively impact the performance of an electron microscope, resulting in less than optimal resolution. The following issues should be addressed early in the planning and design process:

Vibration and Noise: Evaluate the building and the adjacent areas around the EM room, particularly noting mechanical and electrical equipment. Ensure building structure provides for adequate stability and vibration characteristics, and provide vibration attenuation and other remediation measures as required.

HVAC: Airflow at the column should not exceed 20 feet/minute and ideally be less than 15 feet per minute. Depending on the application, chilled beams, radiant cooling panels or laminar flow diffusers should be considered.

Ensure that the room is provided with pressure differential control and ensure any door closing system does not create hard closing impacts or additional loud closing sounds.

References and Further Reading

1. Muller et al., Ultramicroscopy, in press 2006, Room Design for High Performance Electron Microscopy http://www.sciencedirect.com/science/article/pii/S0304399106001033
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