Transforming a Scanning Electron Microscope into a TEM

Description

Although both a scanning electron microscope (SEM) and a transmission electron microscope (TEM) utilise electrons, their operational principles and resulting images differ significantly. An SEM generates images by using secondary electrons ejected after a sample's surface is bombarded with primary electrons. In contrast, a TEM resembles an X-ray machine, using a sensor positioned behind the sample to detect primary electrons after they have traversed the sample. Notably, it is feasible to convert an SEM into a TEM with some ingenuity, as demonstrated in a recent project by ProjectsInFlight.

Previously, coverage highlighted how the SEM, initially slated for disposal, was revitalised and is now undergoing a notable enhancement. This transformation from SEM to TEM, termed scanning transmission electron microscopy (STEM), is not a novel phenomenon; it has been achievable for some time using a relatively straightforward reflecting adapter. However, these adapters often carry a hefty price tag that may deter potential buyers, yet they are sufficiently simple that some might opt to construct one independently.

The primary challenge in creating a DIY adapter lies in maintaining appropriate clearance between the sample holder and the delicate internal components of the chamber. This clearance measures just under 14 mm (0.55 inches), which restricts available space, though using a streamlined aluminium sample plate significantly increased the available room for essential elements such as the primary electron mirror.

After completing extensive machining processes, the sample holder was fully assembled. During evaluations, a modification allowed for adjusting the mirror angle within the evacuated vacuum chamber, optimising the adapter's performance. Initial tests featured gold nanoparticles, which highlighted a deficiency in the secondary electron shield.

Subsequent experiments indicated that the shield required a higher extension for effective blockage of secondary electrons, resulting in a marked improvement in TEM imagery. A mosquito, preserved and no longer viable, provided wings for analysis, revealing intricate structures through TEM imaging.

The next objective involves TEM imaging of biological cells, which necessitates thorough preparation.

Vocabulary List:

1. **secondary** /ˈsɛkəndɛri/ (adjective): coming after the first; not the main one
2. **traversed** /trəˈvɜrst/ (verb): moved across or through an area or space
3. **adapter** /əˈdæptɚ/ (noun): a device that joins or changes equipment
4. **clearance** /ˈklɪrəns/ (noun): the empty space needed to allow movement
5. **evacuated** /ɪˈvækjueɪtɪd/ (adjective): emptied of air or people; made space empty
6. **intricate** /ˈɪntrɪkət/ (adjective): very detailed and made of many small parts

Comprehension Questions

Multiple Choice

1. What does an SEM generate images from?

   Option: Primary electrons
   Option: Secondary electrons
   Option: X-rays
   Option: Optical light

2. What is the purpose of the sensor in a TEM?

   Option: To ejected secondary electrons
   Option: To detect primary electrons
   Option: To modify the sample
   Option: To produce secondary images

3. What is the term for converting an SEM into a TEM?

   Option: Electron scanning
   Option: Scanning transmission electron microscopy (STEM)
   Option: Optical enhancement
   Option: Microscopic adaptation

4. What is a significant challenge in creating a DIY adapter for an SEM?

   Option: Cost of materials
   Option: Maintaining appropriate clearance
   Option: Finding suitable samples
   Option: Complex construction

5. What enhancement was made to the adapter during evaluations?

   Option: Increased power
   Option: Mirror angle adjustment
   Option: New sensor technology
   Option: Additional parts

6. What biological subject was used for analysis in the experiments?

   Option: Bacteria

Option: Viruses
Option: Mosquito wings
Option: Animal cells

True-False

7. An SEM and a TEM operate on the same principles.

8. It is complicated to convert an SEM into a TEM.

9. The clearance required for the adapter is more than 14 mm.

10. Initial tests showed sufficient effectiveness of the secondary electron shield.

11. The adapter's performance improved after adjustments were made.

12. The next objective is TEM imaging of geological samples.

Gap-Fill

13. An SEM generates images by using secondary electrons ejected after a sample's surface is bombarded with primary electrons in _____.

14. The clearance measures just under 14 mm (0.55 inches), which restricts available space, though using a streamlined aluminium sample plate significantly increased the available room for _____.

15. The primary electron mirror was adjusted to optimize the adapter's _____.

16. Subsequent experiments indicated that the shield required a higher extension for effective _____ of secondary electrons.

17. A mosquito, preserved and no longer viable, provided _____ for analysis.

18. The next objective involves TEM imaging of biological cells, which necessitates thorough

_____.

Answer

Multiple Choice: 1. Secondary electrons 2. To detect primary electrons 3. Scanning transmission electron microscopy (STEM) 4. Maintaining appropriate clearance 5. Mirror angle adjustment 6. Mosquito wings
True-False: 7. False 8. False 9. False 10. False 11. True 12. False
Gap-Fill: 13. contrast 14. essential elements 15. performance 16. blockage 17. wings 18. preparation

CATEGORY

1. Sci/Tech - LEVEL6

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4. Level 6
5. scanning electron microscope
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Date Created
2026/06/15
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