The Function of the Scanning Electron Microscope (SEM)

Arianna Swindle
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Motivation

Electron microscopes are capable of imaging objects not visible to the naked eye. How exactly does the SEM work? What factors affect the quality of the specimen and images?

Background

The SEM is a instrument used to image specimens at a microscopic level. A beam of electrons is used to scan the surface of a specimen. Detectors within the SEM collect electrons to produce an image. (1)

There are two different types of electrons detected (2)

- **secondary elections** = elections that are knocked off the surface of the specimen
- **backscattered electrons** = beam electrons that are deflected by the surface

Methods

Sample needs to be fixed and dried before being inserted into SEM. (1)

1. **Primary Fixation:** 2.5% glutaraldehyde
2. **Secondary Fixation:** 1% osmium
3. **Dehydration:** graded series of ethanol (30%-100%) to remove water
4. **Remove ethanol:** chemically dried with 100% HMDS

Note: all steps were done in microwave to speed up the procedure

Coating can be done for conductivity, which helps the electrons flow.(1)

- Gold and carbon coating are the most common

Results

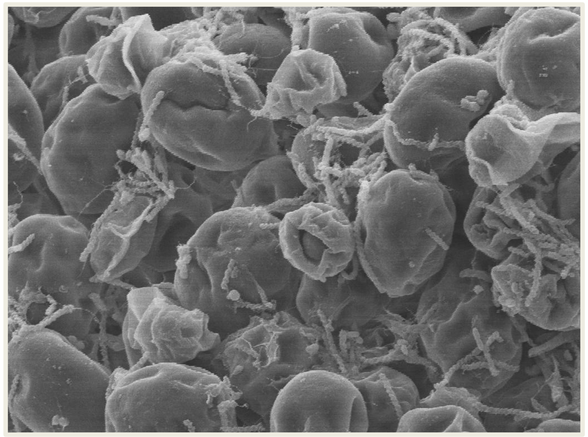

Figure 1: Portion of chameleon embryo gold coated taken at magnification 3.00kx and 10 kV

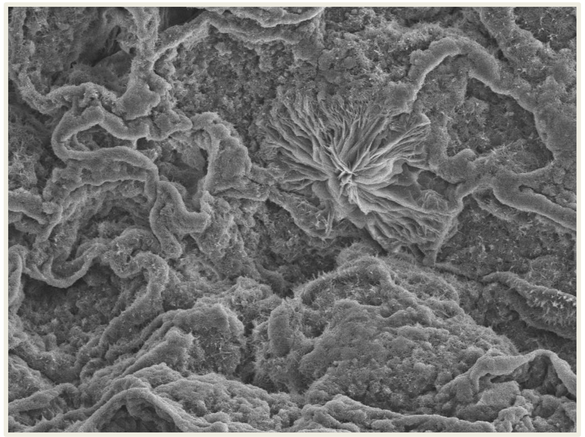

Figure 2: Lemon slice coated in gold taken at magnification 900x and 10 kV

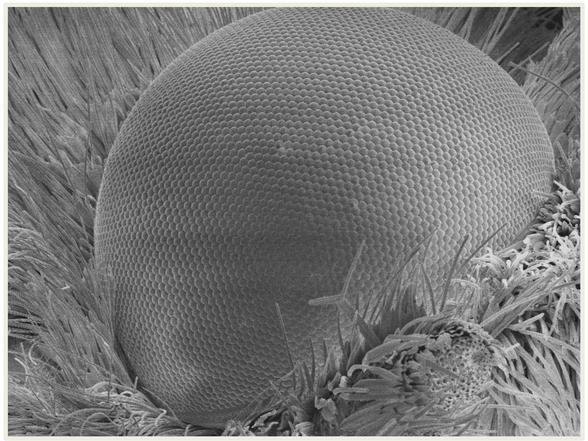

Figure 3: Eye of a tiger moth taken at magnification 70x and 5 kV

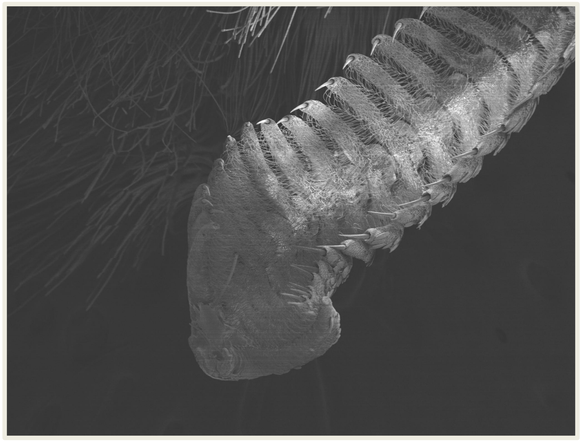

Figure 4: Potion tiger moth antenna coated in gold taken at magnification 60x and 5kV

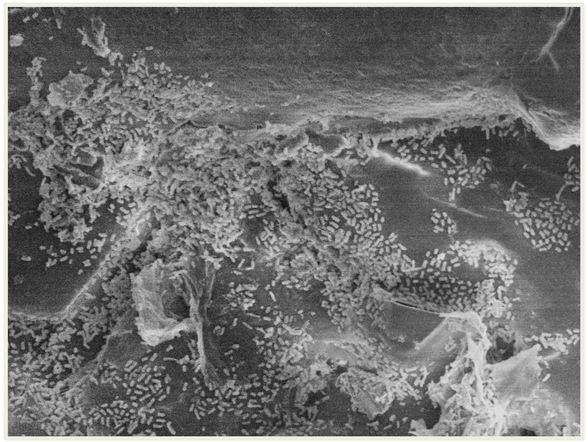

Figure 5: Potion of used kitchen sponge gold coated taken at 15kV

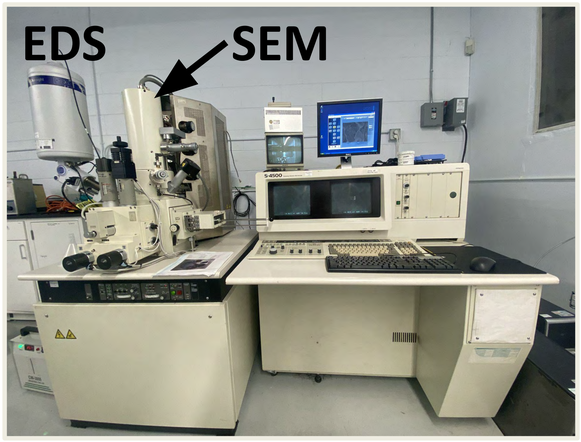

Figure 6: Image of the Hitachi S-4500 SEM used with the EDS labeled.

Discussion

Preparation will be based on the structure and the condition of the specimen. The method conducted in this study would be beneficial for bacteria and other delicate specimen.

The voltage used while imaging will be determined by the conductivity of the specimen.

Future Work

Use the energy-dispersive X-ray spectroscopy (**EDS**) that is attached to the SEM

The **EDS** collectes x-rays from the scan and generates elemental graphs

- these electrons go into an excited state and release element specific x-rays in order for them to go back to a ground state (3)
- help you differentiate what kind of sample you are working with

Acknowledgements

I would like to thank my mentor Dr. Paul Webster, Marianne Smith, Oak Crest Institute of Science, and Citrus College for this opportunity. Additionally, thanks to Alex Gomez, Sarahai Jimenez, and Lisa Wang for helping me with this project. This project was funded thanks to Project STARS, a U. S. Department of Education Title III HSI-STEM grant.

References

(1) Scanning Electron Microscopy. *Central Microscopy Research Facility*. University of Iowa. https://cmrf.research.uiowa.edu/scanning-electron-microscopy. Accessed 10 August 2022

(2) Abd Mutalib, M., Rahman, M. A., Othman, M. H. D., Ismail, A. F., & Jaafar, J. (2017). Scanning electron microscopy (SEM) and energy-dispersive X-ray (EDX) spectroscopy. *Membrane Characterization*, 161–179. doi:10.1016/b978-0-444-63776-5.00009-7

(3) Shindo, D., & Oikawa, T. (2002). Energy dispersive X-ray spectroscopy. *Analytical Electron Microscopy for Materials Science*, 81–102. doi:10.1007/978-4-431-66988-3_4

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Alternate Text

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Oak Crest- STARS

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