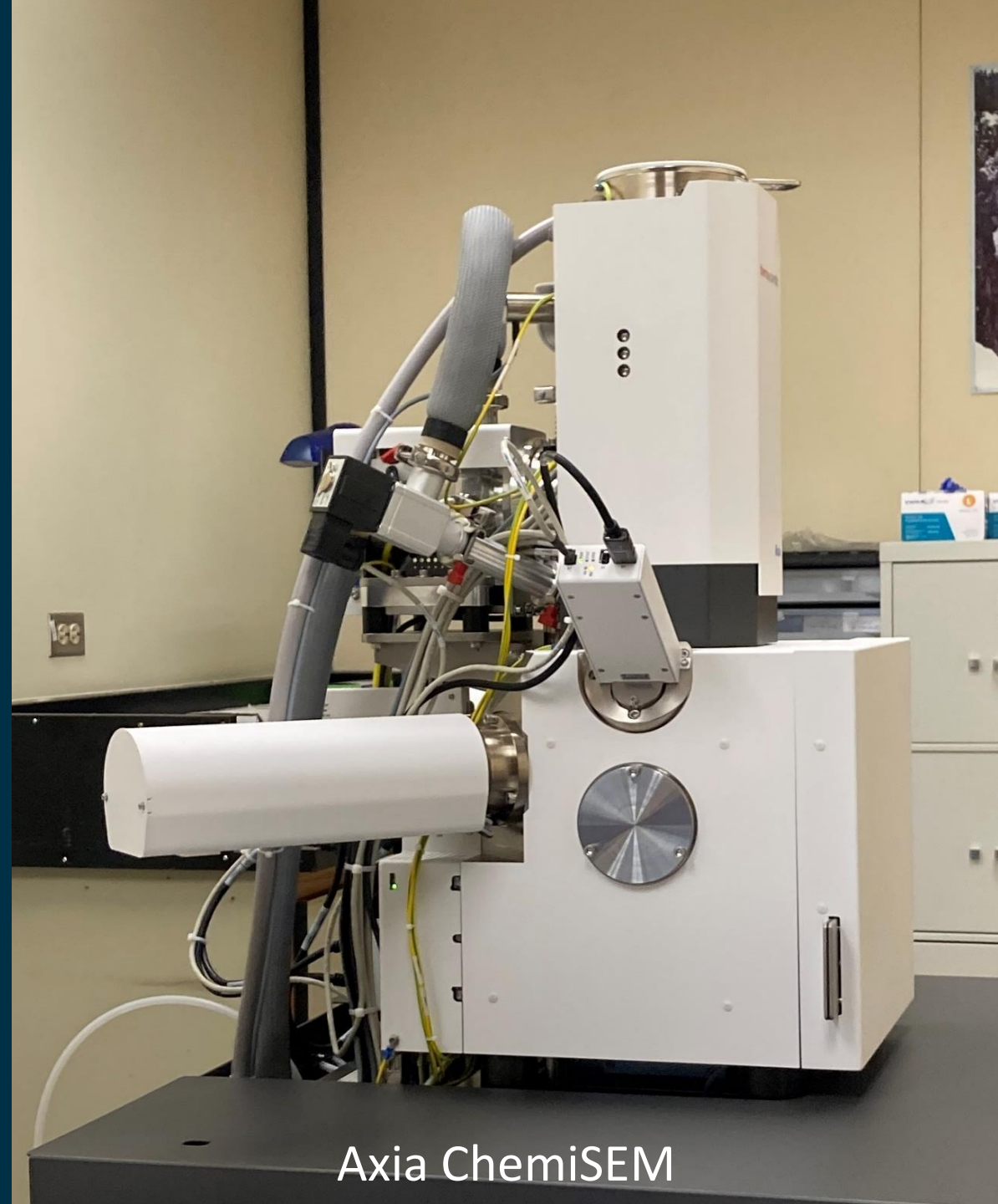


Studying Solar Panels with SEM: Assumptions and Lessons Learned

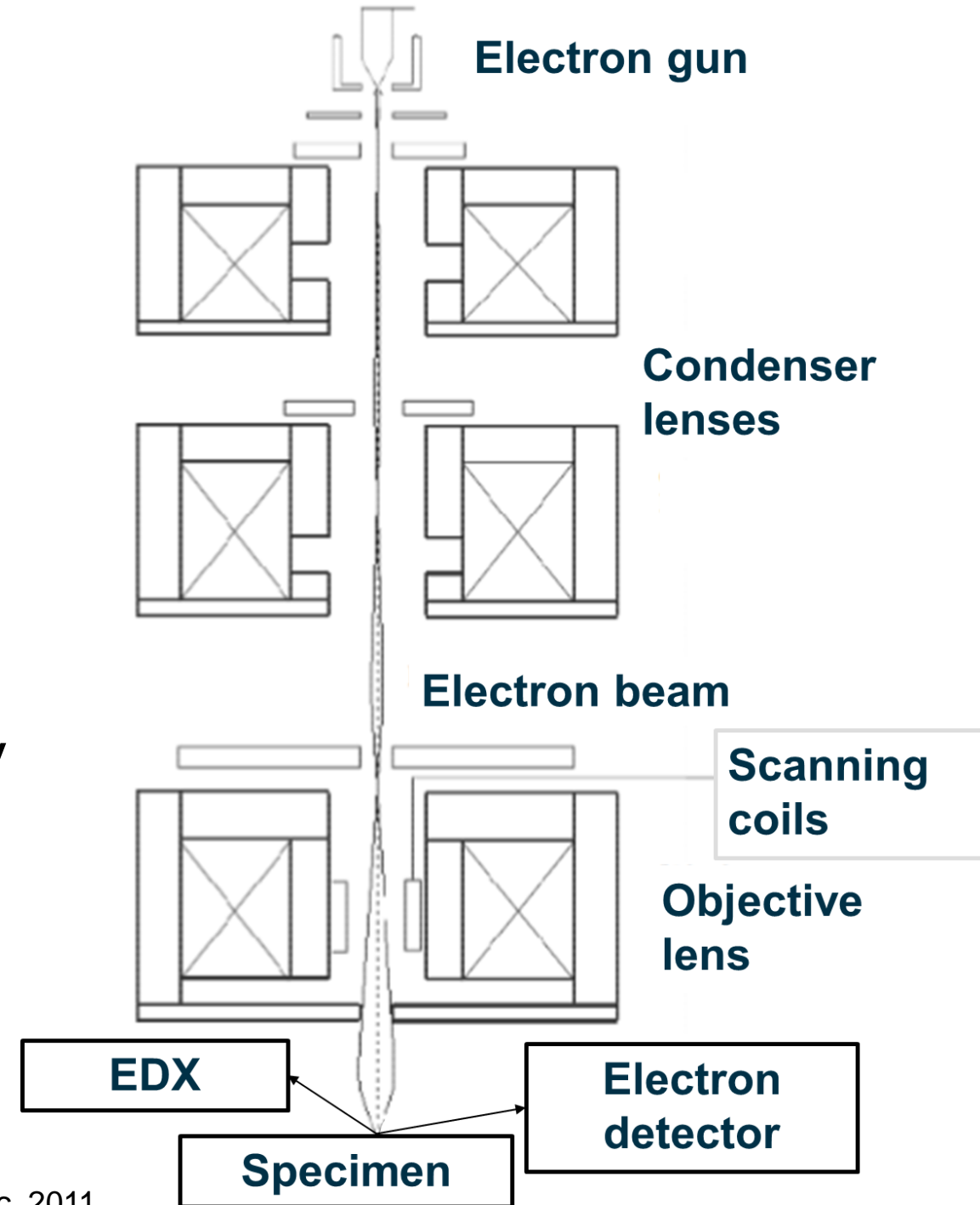
Kieren O'Neil,
Anusha Venkataraman,
Nancy Van Wagoner



Axia ChemiSEM

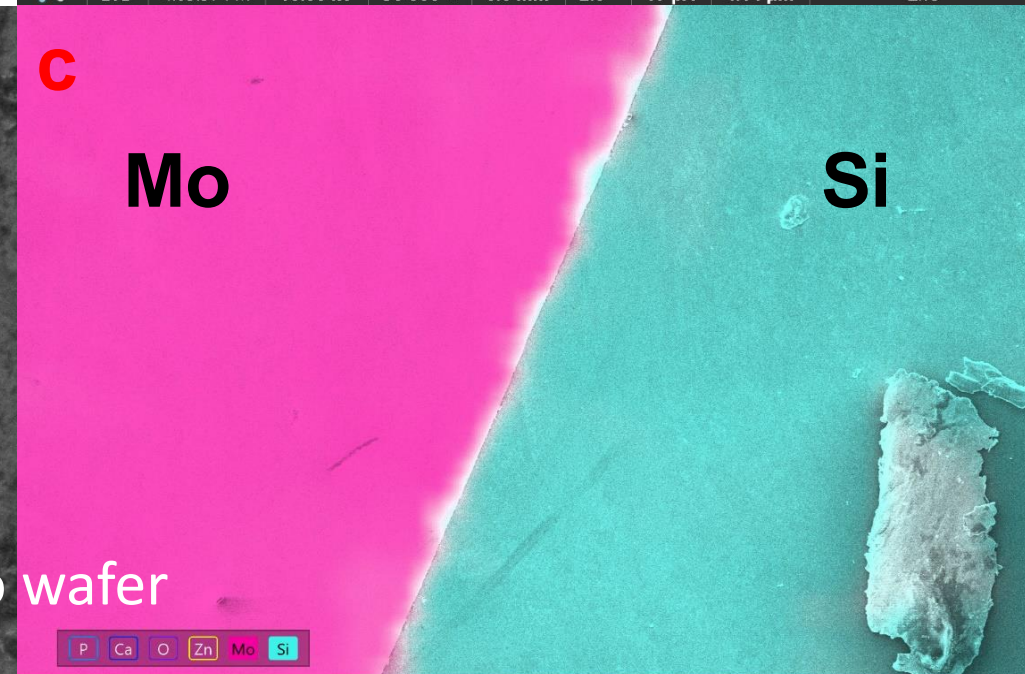
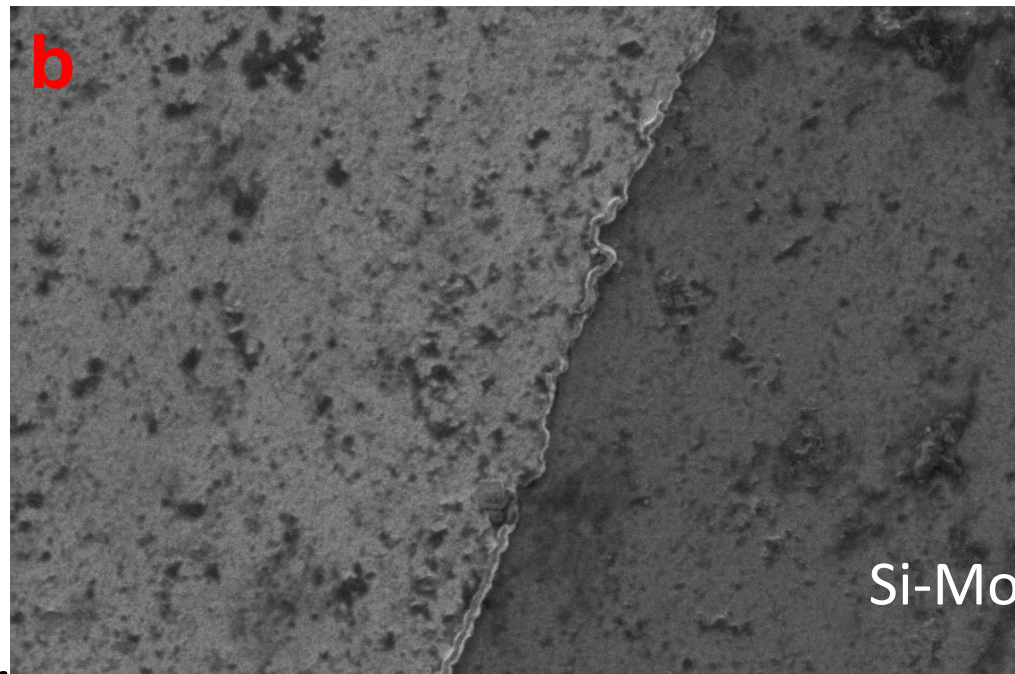
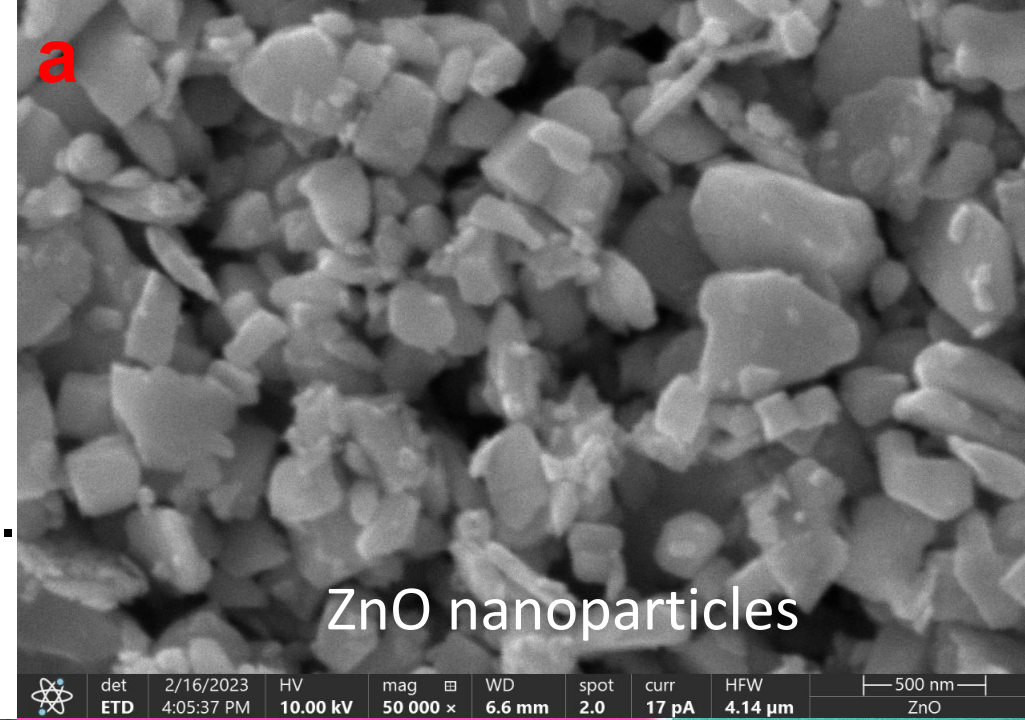
SEM

- Electrons can be used to image smaller structures (3 nm vs 200 nm).
- SEM uses an electron beam to image samples.
- Integrated Energy Dispersive X-ray Spectrometer (EDX) analyzes composition.



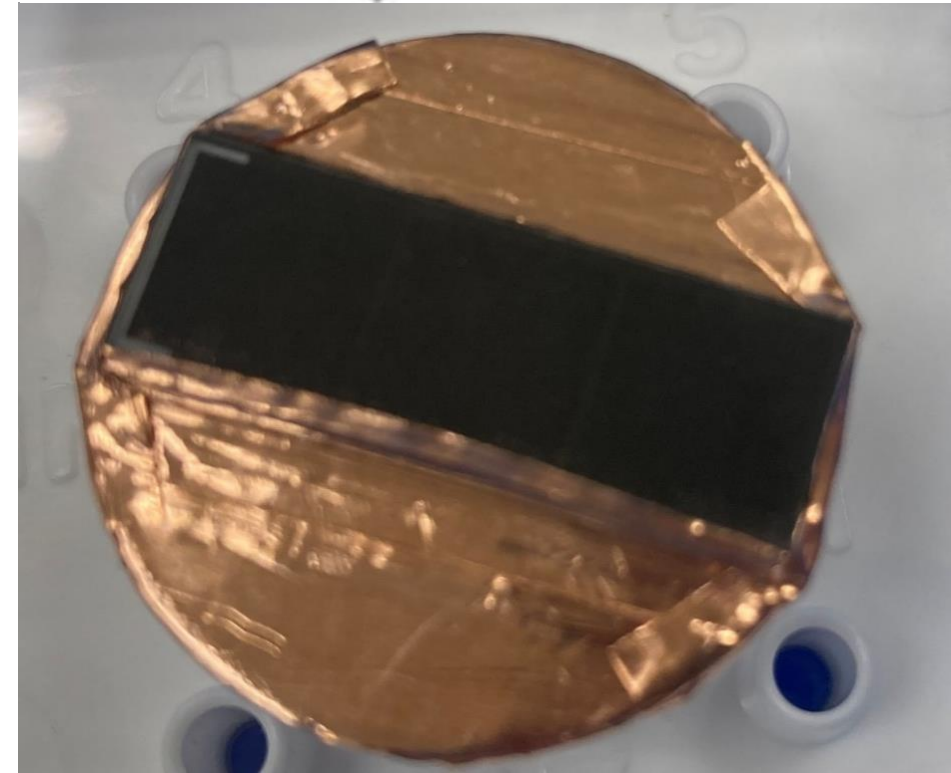
Test samples

- These showed the structure and composition of semiconductor samples.
- We wanted to extend this to the solar panel.



Sample Preparation

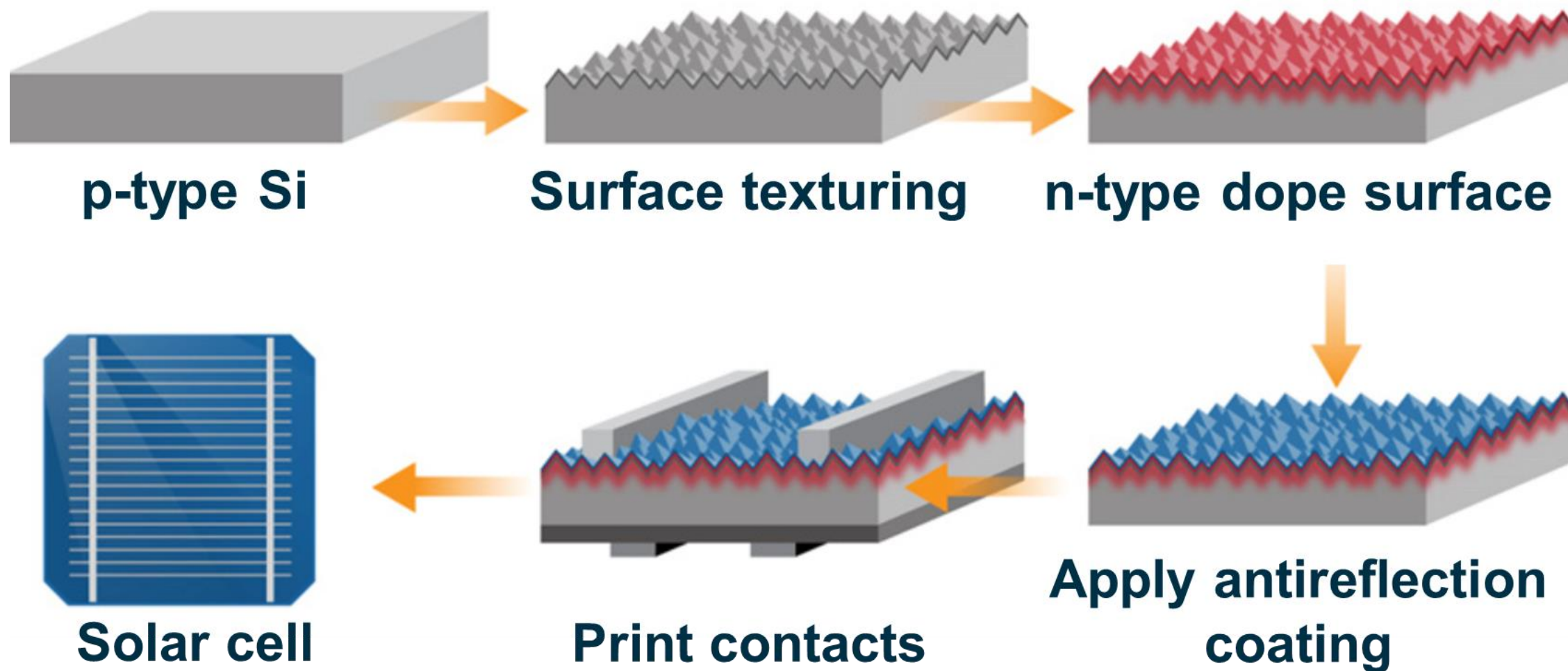
- The solar panel was mounted on an SEM stub with carbon tape.
- Everything except the surface of the solar panel was covered in copper tape.
- It was cleaned with compressed air.



ANYSOLAR LTD., "KXOB25-05X3F-TB IXOLARTM High Efficiency SolarBIT" (accessible:
<https://waf->

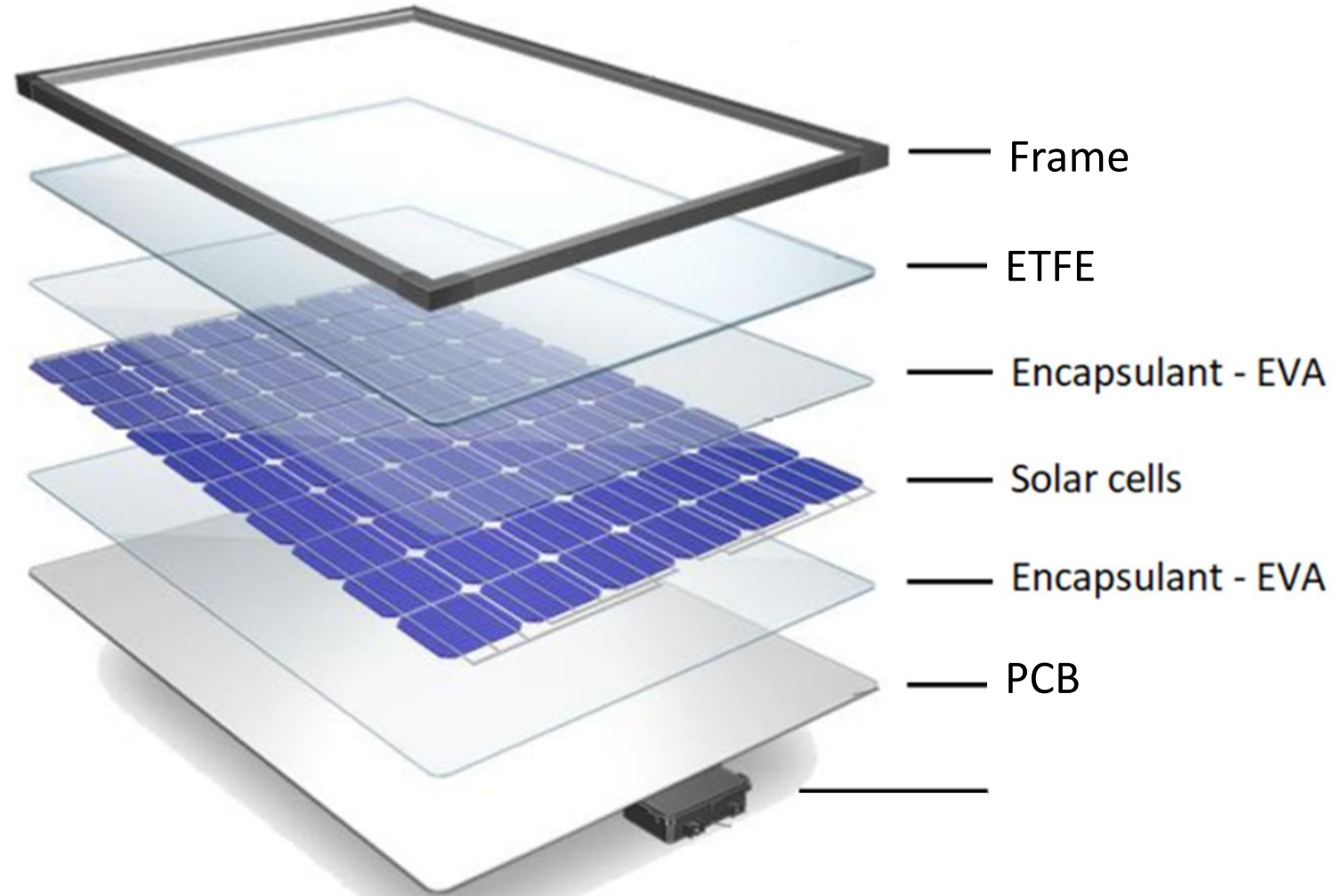
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Solar cell manufacturing



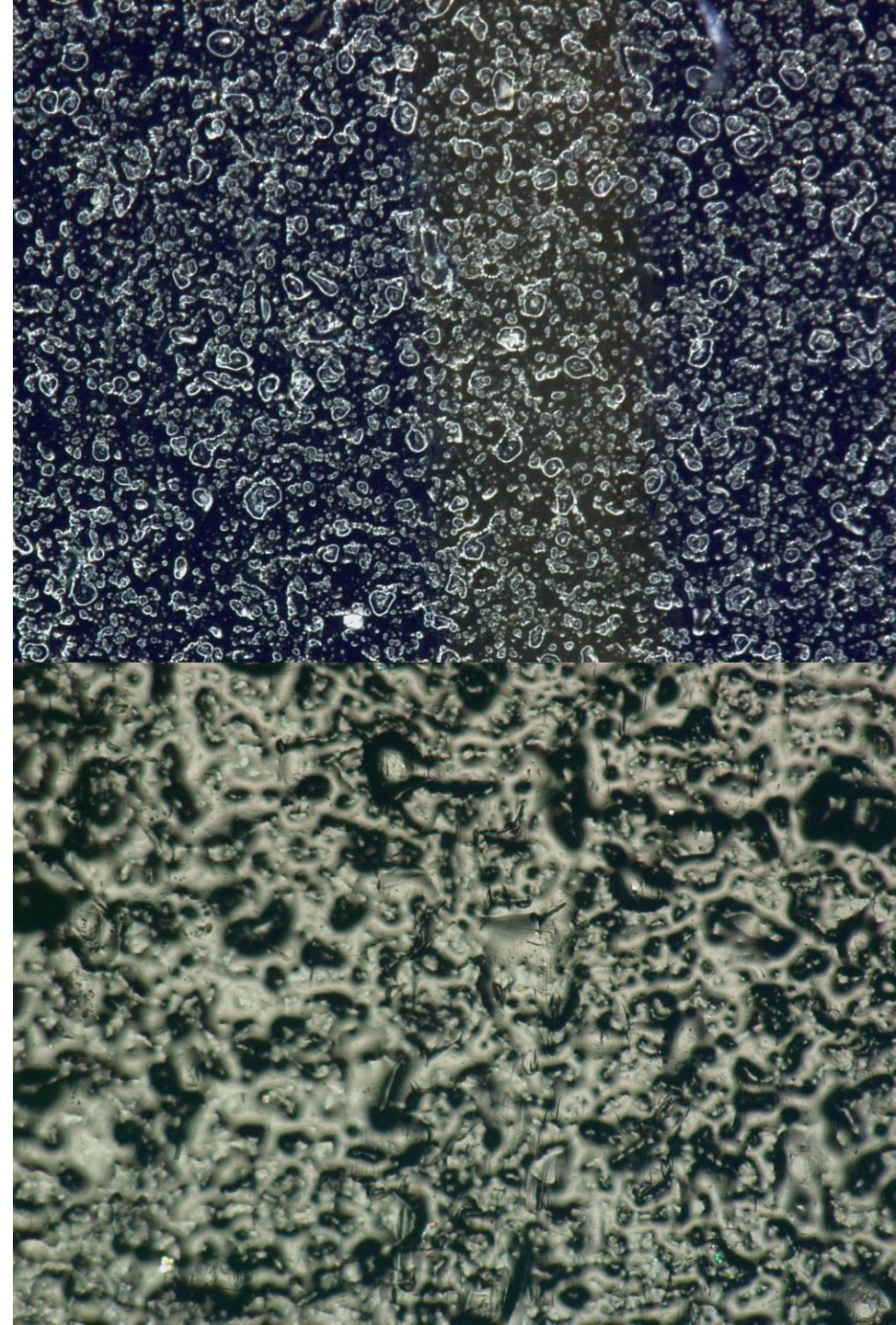
Encapsulation and Lamination

- Solar cells are wired together and encased in additional layers to make a panel.
- These layers protect the solar cells.
- Our solar panel is covered in EVA and laminated with an ETFE film.



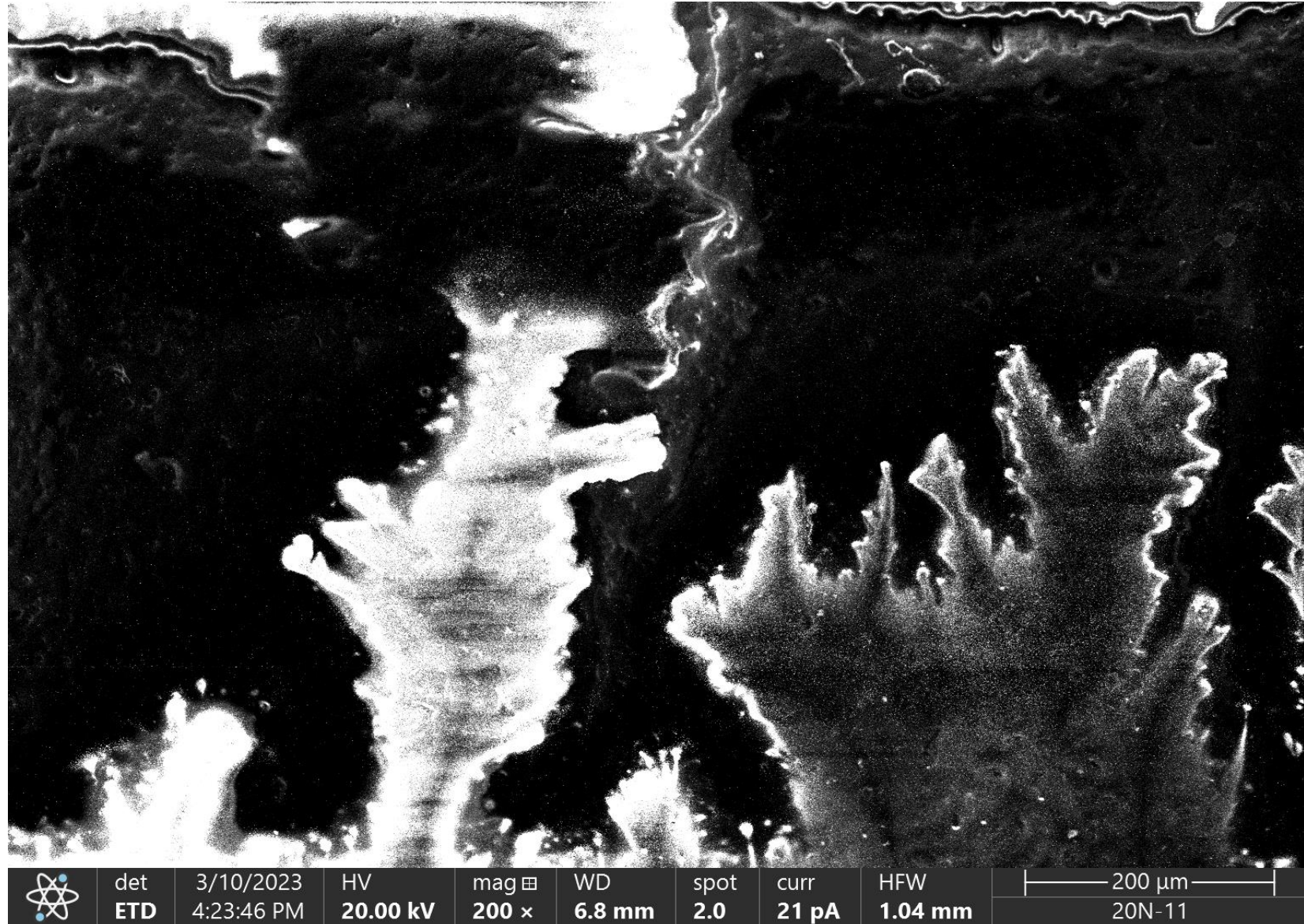
Optical microscope

- Optical microscope images showed roughness on the surface at the scale of several microns
- The panel was difficult to light well
- Top: low directly above lighting FOV 1.5 mm, brown is front contact, blue is silicon viewed through front coating
- Bottom: Increased lighting from an angle, FOV 0.62 mm, texture is shown more clearly.



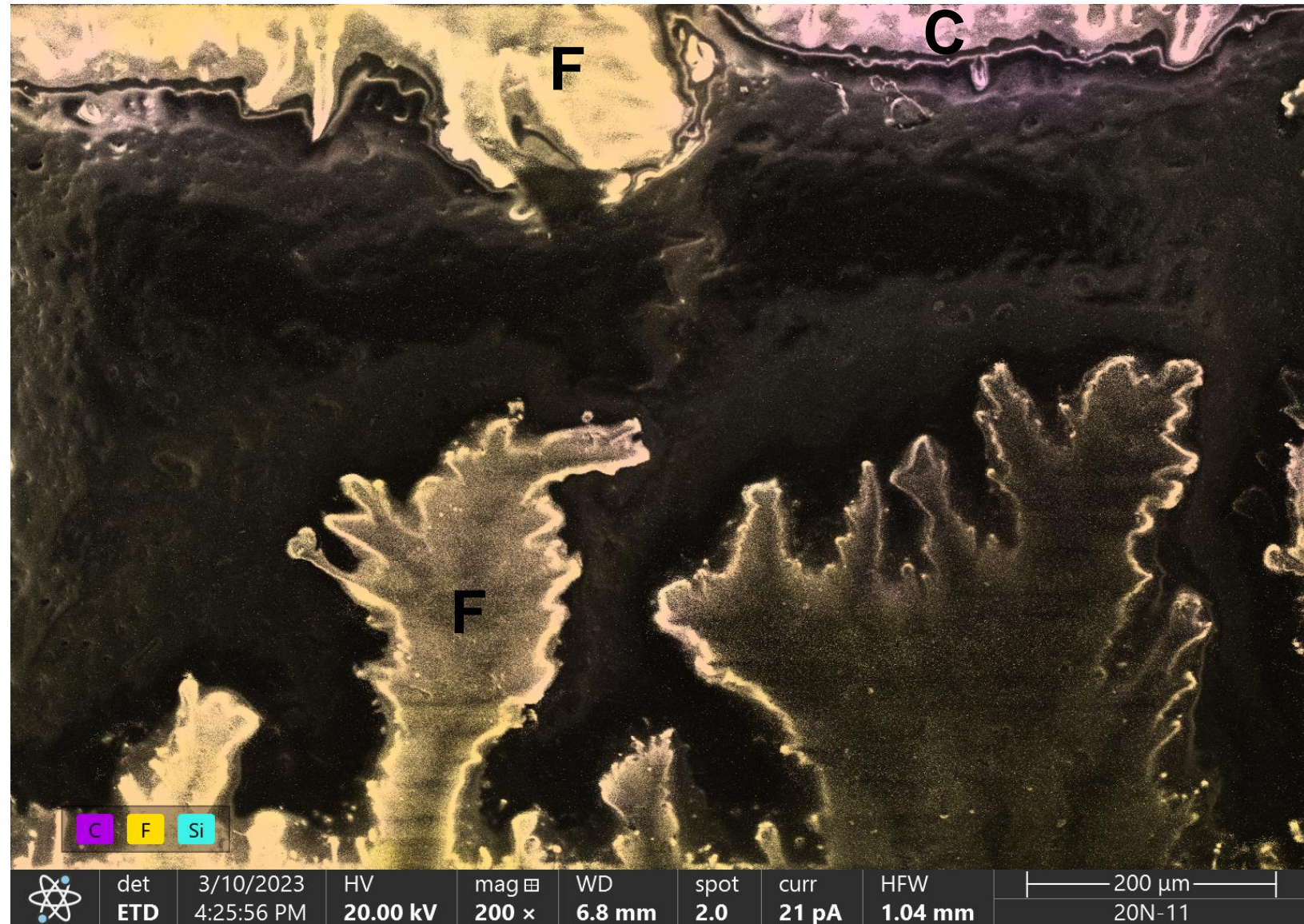
SEM

- We expected the antireflection coating to be exposed for texture and composition analysis.
- The sample showed a flow pattern and some charging.



EDX

- The only material identified in significant quantities was fluorine.
- Shown most strongly on the flow pattern.
- The flow pattern is in the ETFE film on the surface of the panel.



Lessons learned

- The solar panel was not a suitable sample for SEM imaging with the chosen settings, the EVA and ETFE degraded under high energy electron bombardment.
- To examine samples of unknown chemical composition, like volatiles, a thorough understanding of the composition and properties is important before SEM imaging.
- With SEM use low beam energy and current until the sample is well-understood.