Microstructural Characterization of Perovskite Thin Films Using Electron Microscopy

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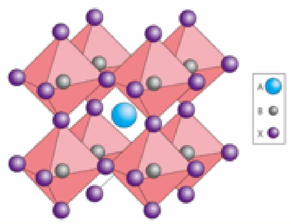
Background:

Perovskite solar cells are low-cost and efficient, but their performance depends on how the thin film is formed. Tiny defects and irregular grain structures can reduce stability and power output. Using electron microscopy helps reveal how processing and surface treatments affect film uniformity and crystal growth, guiding improvements in efficiency and durability.

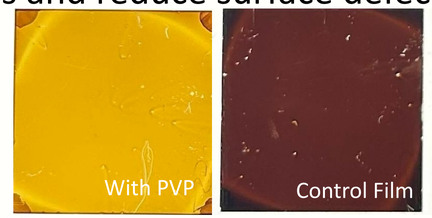


Perovskite Crystal structure

Methodology:

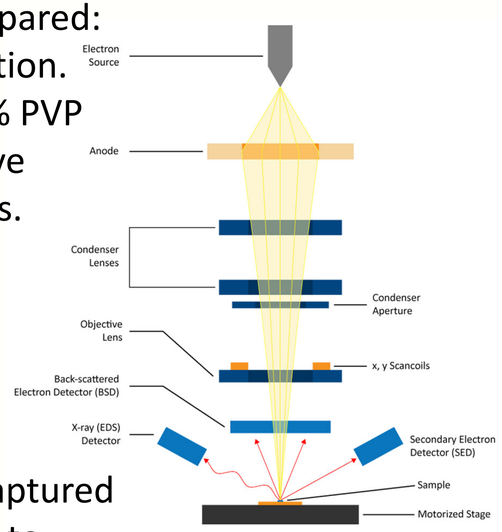
Film Preparation:

Two types of perovskite films were prepared:
Control Film: Standard perovskite solution.
PVP Film: Same base solution with 10% PVP (polyvinylpyrrolidone) added to improve smoothness and reduce surface defects.



SEM Imaging:

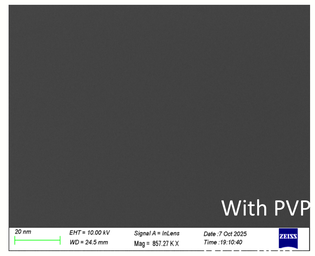
Scanning Electron Microscopy (SEM) captured high-resolution images of film surfaces to observe grain size, boundaries, and surface defects.

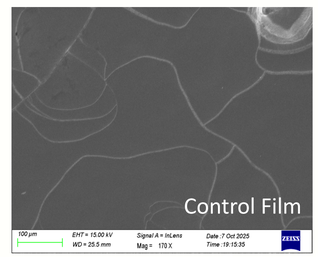


Schematic of SEM

Challenges Faced:

Perovskite films are non-conductive, making SEM imaging difficult due to surface charging. A thin carbon coating was applied, but charging and image distortion still occurred, limiting clarity.

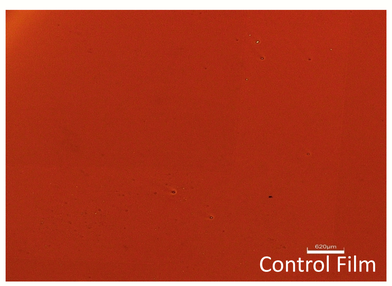


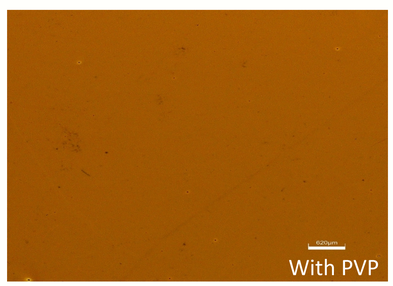


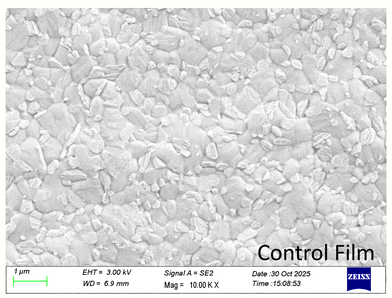
Control and PVP films under SEM showing limited visible features due to charging effects

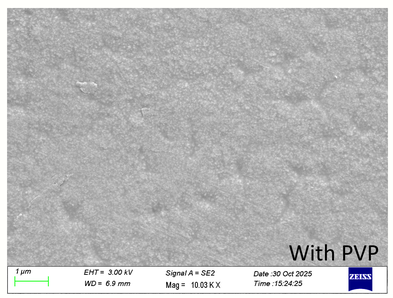
Improved Results:

Switching from carbon to **gold sputtering** improved conductivity and reduced surface charging during SEM imaging. By lowering the accelerating voltage to **3 kV**, we achieved clearer contrast and were able to observe distinct features









Clear grain structures observed in control films; PVP films show smoother, cotton-like aggregates indicating morphological

Future Work

Future work will focus on studying how varying **PVP content** influences the **crystallinity and microstructure** of perovskite films. The goal is to identify a threshold where grain structure is preserved while minimizing the formation of unwanted **PbI_2 phases**. Complementary techniques such as **XRD** and **AFM** will be used to confirm structural and surface changes.