Dual-Additive Engineering to Improve Electronic and Mechanical Properties of Metal Halide Perovskites

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Motivation

Perovskite Solar Cells(PSCs) promise high efficiency at low cost, but are unstable limiting their practicality.

Goal: boost perovskite stability without extra manufacturing steps for low cost solar electronics.

Additives used :

- **Polyvinylpyrrolidone (PVP)**: a mechanical stabilizer
- **Self-Assembled Monolayer (SAM)**: increases carrier transport

Research methods

Film Preparation: Triple Halide Perovskite thin films were spin coating on plain glass substrates using two deposition techniques:

- **Co-deposition(CD)**: Adding both the Additives directly to the PSK ink
- **Sequential Deposition(SD):** Adding the SAM layer followed by the PSK ink

Characterization tools: Microscopy, and Glow Discharge Optical Emission Spectrometry(GDOES)

Results

Graph 1: CD PSK without PVP(Fig 2)

Graph 2: CD PSK with PVP(Fig 4)

Films containing both additives(Fig 4 and Fig 5) show superior surface uniformity suggesting improved ink.

Co-deposition results in denser, smoother films whereas Sequential deposition results in more uniform transparent films.
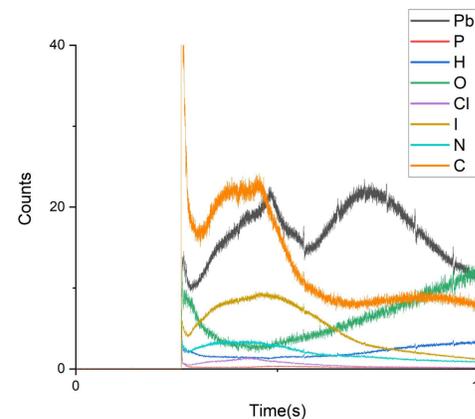
Uniformity → better coverage → higher efficiency

Graph 1 and 2 show the GDOES results for the difference made by PVP, which massively increases the carbon and lead concentration.

Fig 1: Triple Halide PSK

Fig 2: TH PSK and SAM(CD)
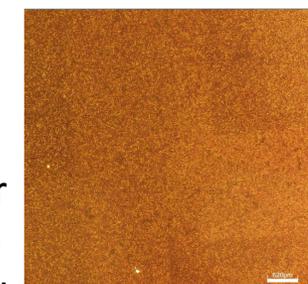
Fig 3: TH PSK and SAM(SD)

Fig 4: TH PSK, PVP & SAM(CD)

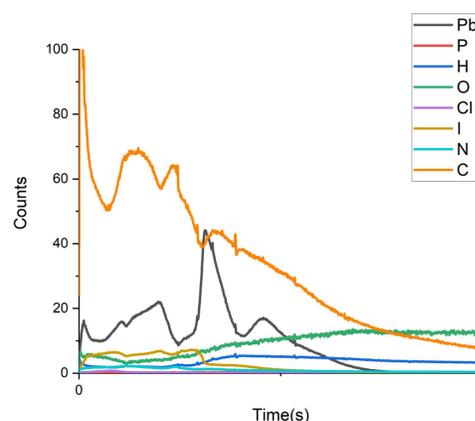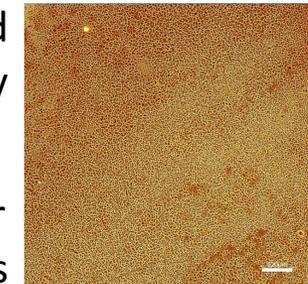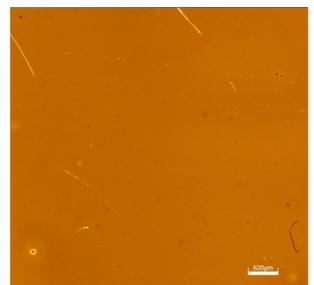*Fig 5: TH PSK, PVP and SAM(SD)*

Conclusion

This shows that both deposition techniques with SAM and PVP significantly optimize perovskite performance. The deposition technique should be chosen based on device requirements.

Future work

To improve characterization accuracy, future studies will use ITO glass substrates to increase phosphorus signal visibility on the GDOES results. The next step is to fabricate complete perovskite solar devices with the noted improvements.

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