The Effects of Solvent on Thin Film Coatings for Perovskite-Oxided-Based Solar Cell

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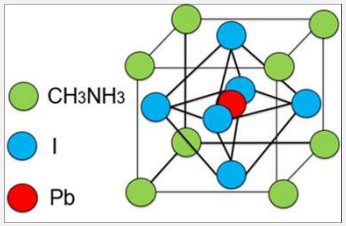
Overview

- Perovskite solar cells (PSC) are an emerging type of photovoltaic cell, with reported device stability over 1000 hours and efficiencies of 12.8% [1].
- Inkjet printing the mesoporous thin films of methylammonium lead halide PSC would allow for mass production of the technology.
- For inkjet printing, is important to determine which solvent/powder combination produces the most homogeneous thin film coating.

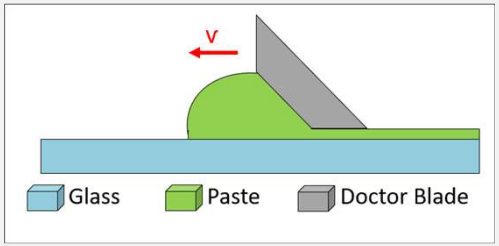
Methylammonium lead halide (MAPbI3) perovskite crystal structure. This crystal is what creates pairs of electrons and holes, which is fundamental for electricity generation.



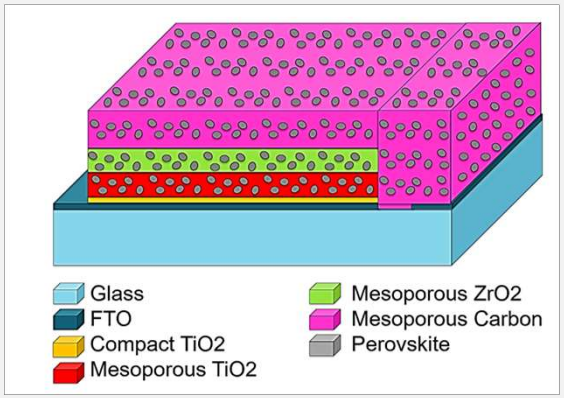
Methodology for Perovskite Solar Cell Fabrication

- FTO glass is etched using Zn flakes and 2M HCl.
- ALD is used to deposit a layer of compact TiO_2.
- TiO_2, ZrO_2, and C powders are mixed with solvents to create slurries.
- Mesoporous TiO2, ZrO2, and C pastes are deposited using a doctor-blade technique and annealed at temperatures between 450 – 550 °C.
- MAPbI3 perovskite is deposited via drop-casting in inert atmosphere.

Etching FTO glass with Zinc flakes and 2M HCl



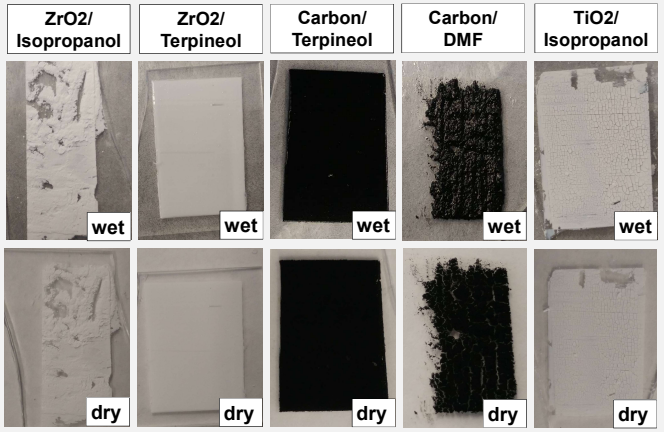
Schematic of doctor blading, which is very similar to inkjet printing.



Schematic of PSC our group is creating

Results: Visual Images of Pastes

- Terpineol and DMF solvent slurries resulted in the most uniform thin films for TiO_2 and ZrO_2 nanopowders.
- Isopropanol slurries resulted in flaking thin films and proved difficult to apply.
- Carbon particles exhibited heterogeneous suspension in both the DMF and isopropanol solvents.
- The carbon with terpineol film looks the most homogeneous in images, but did not adhere to the glass.



Images of various powder/solvent combinations, both wet and dry results.

Acknowledgements

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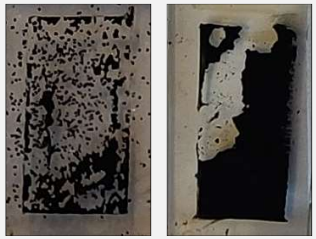
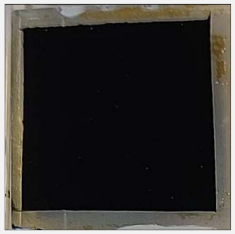


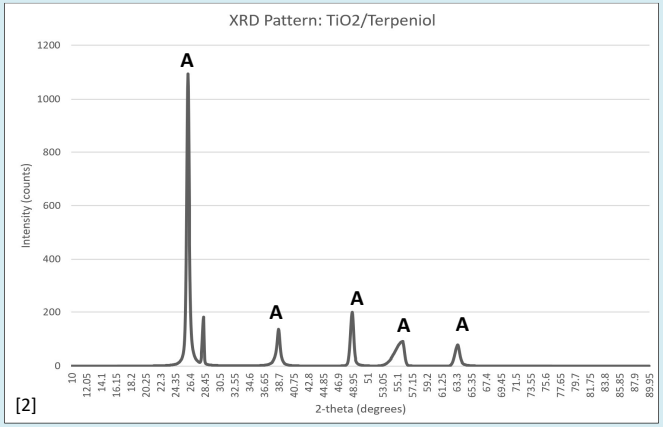
(left) Images of carbon samples flaking off glass substrate.



(right) Mesoporous films on etched FTO glass. Next steps include drop-casting the perovskite crystal onto the films.

Results: XRD for Confirmation of TiO2 Formation

- X-ray Diffraction (XRD) was used to confirm annealing of TiO_2 paste.
- Anatase structure (**A**) is present in the resulting TiO_2 film.



[2]

Continuing Work

- Reduce paste viscosities to match commercial ink viscosities.
- Application of Kapton tape as the masking material during ALD of compact TiO_2.
- Create and drop-cast perovskite crystal onto mesoporous thin films in inert environment.
- XRD of ZrO_2 and C thin films, as well as completed PSC
- Incorporation of inkjet printer instead of doctor blading for paste deposition.

References

[1] A. Mei, *Science* **345**:6194 (2014) 295 – 298.
[2] N. Kourkoumelis, ICDD Annual Spring Meetings, Powder Diffraction, 28 (2013) 137-48.