Electrically assisted 3D Printing of PEDOT:PSS Film for Solar Cell Fabrication

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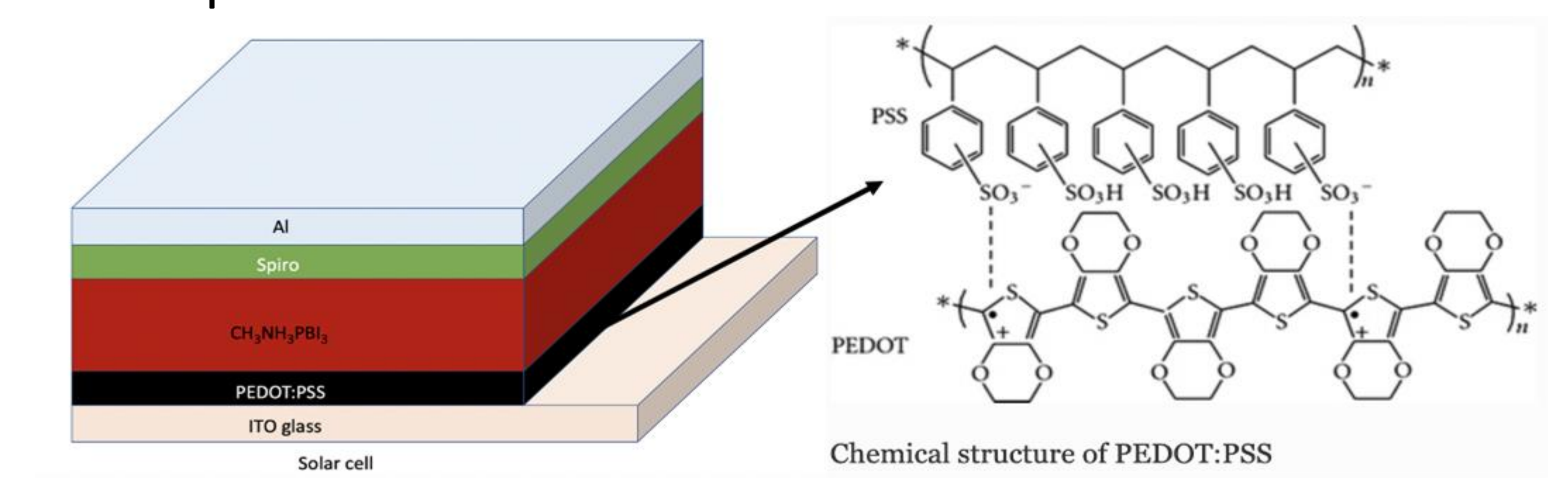
1. Introduction

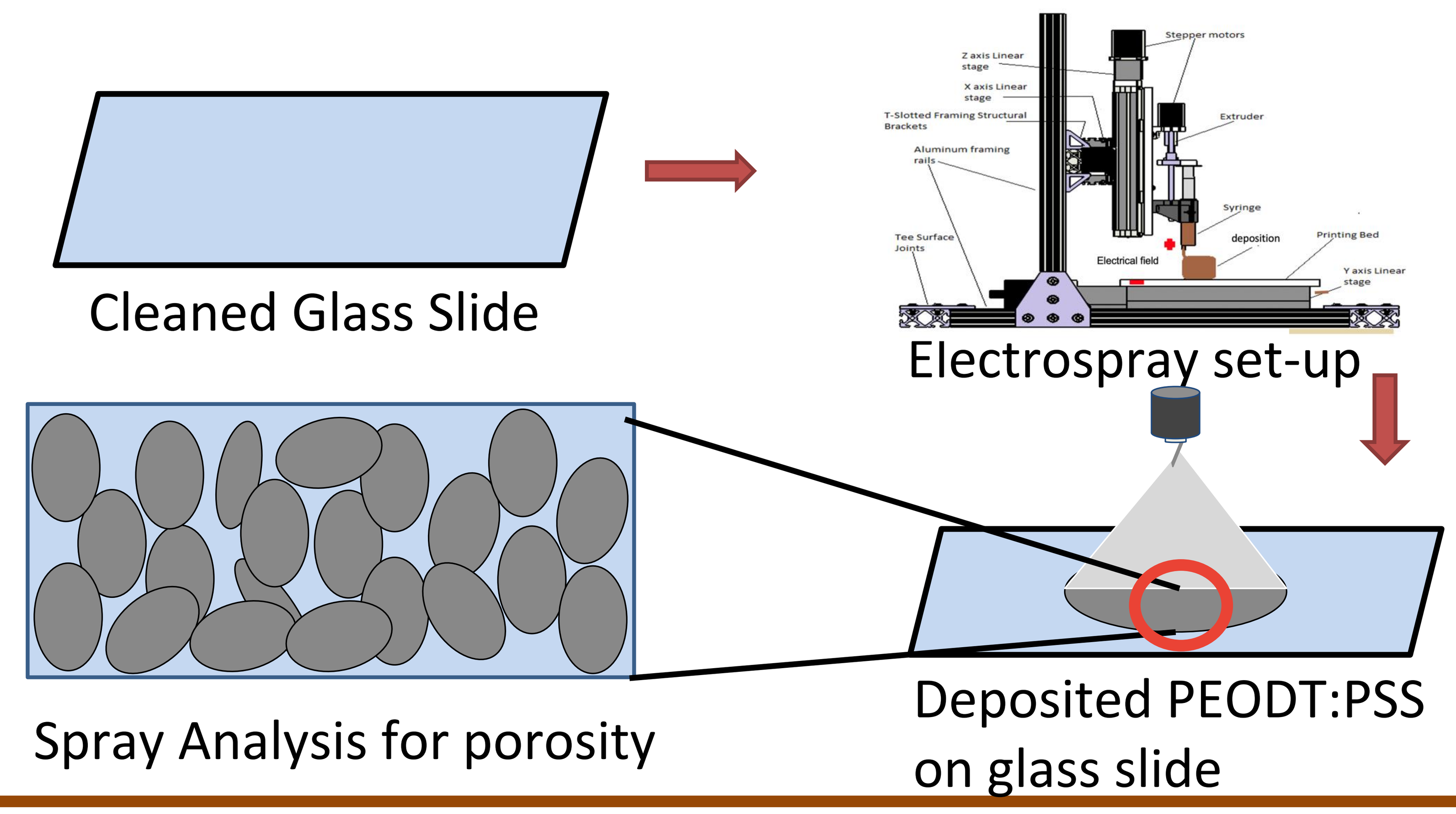
Perovskite based-solar cells represent a promising solar cell for the future. These solar cells are multi-tiered composites of different materials that work in tandem. Perovskite lab trials, show that the material synergizes with others in a way that allows for a high efficiency solar cell. However, these trials were conducted on small-scale set-ups. This is due to the difficulty of producing these solar cells in a scalable manner. Spin coating is one of the strategies for covering a large area with PEDOT, but current methods have resulted in lower efficiencies than the small samples.



Chemical structure of PEDOT:PSS

2. Abstract

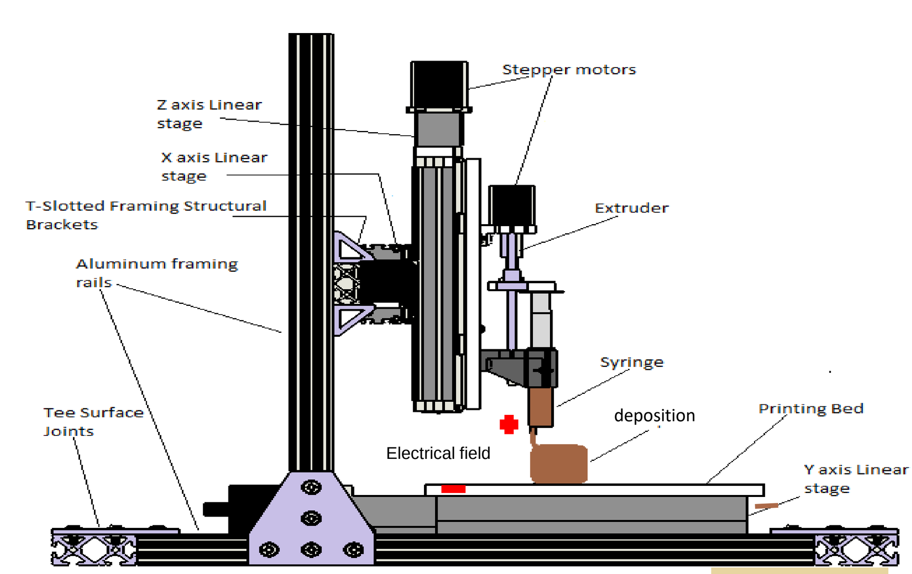
PEDOT:PSS based solar cells are a promising renewable energy source. They have exhibited high energy efficiency while still maintaining stability. The problem with these types of solar cells is that they are not easy to produce in large quantities. Current methods of material deposition rely on spin-coating, which is acceptable for small scale manufacturing but not for large-scale production. This proposed research seeks to develop a scalable 3D printing process to make large-scale production viable. In this project, process parameters, including the material concentration, electrical field strength, extrusion speed etc. will be studied to improve the printing quality.



3. Construction of Electrospray set-up

Overview of the Electrospray process

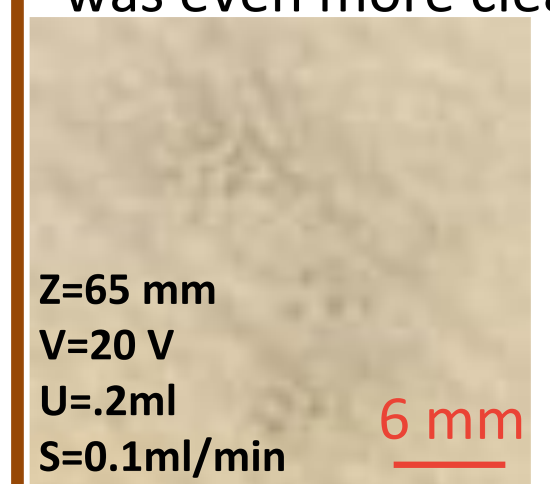
In the electrospray process, PEDOT solution is deposited from a syringe suspended above a glass substrate. The machine uses four step motors to control the extrusion process. Three of the step motors motivate the arm in three coordinate planes. The fourth step motor moves the plunger of the syringe, allowing for filling and voiding. A wire is wrapped about the needle of the syringe. The coiling of the wire creates an electric field about the needle. The particles are then dispersed in a wide, conical trajectory.

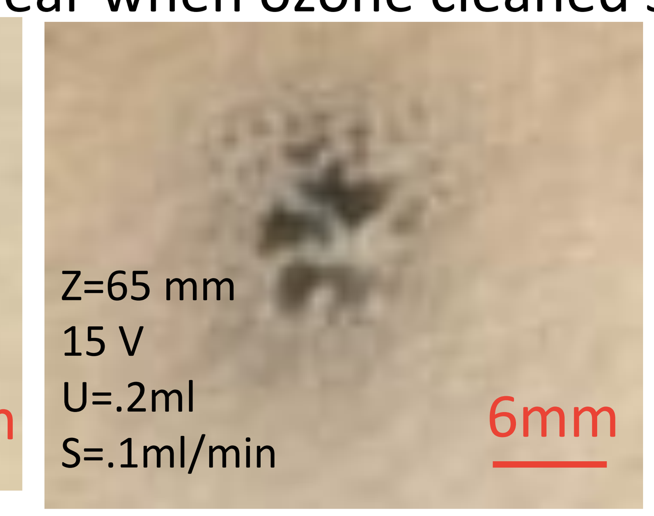


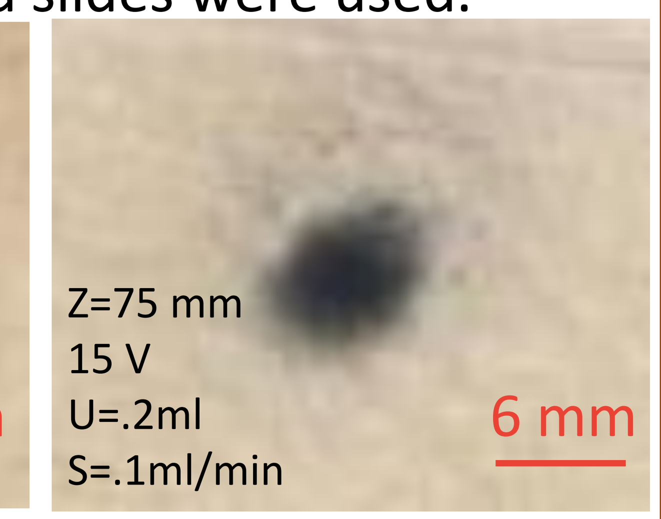
The goal of these experiments was to find an even, wide, and dense spray. To find this, our goal centered around diameter of the spray and the deposition parameters that affect it. The primary parameters of diameter spread were determined to be: volume of fluid and speed, voltage, and height from substrate. From here, the results were iterated on to improve deposition.

Effects of Deposition Parameters

Each of these settings had a distinct impact on the diameter of the sprays. Voltage (marked by "V") caused a wider misting effect of the spray, but became unstable as voltage increased. Volume ("U" parameter) and speed ("S" parameter) combined affected dispersion. Height ("Z" Parameter) caused tighter spread, this was even more clear when ozone cleaned slides were used.







4. Future work

1. Property measurement and evaluation of 3D printed PEDOT: PSS layer
2. Take microscopy images to study the micro and nanostructures
3. Evaluate density and electrical conductivity

Acknowledgments

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