Substrate-solvent interactions to ensure homogeneous deposition of perovskite for large area high efficiency solar cells

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In 2009 a lead iodide based perovskite was shown to be a sensitiser for a dye sensitised solar cell[1] replacing the dye to make a 3% efficient device. From this work the perovskite cell was developed, using a solid state hole conductor[2]. The research on these cells since 2012 has seen an increase in the verified efficiency from 13% to 20.1% in just two years. In order to realise the commercial potential of these devices larger scale printing methods need to be employed. Multiple architectures can be employed when using a perovskite adsorber materials, Fig. 1 demonstrates the two architectures used in this work.

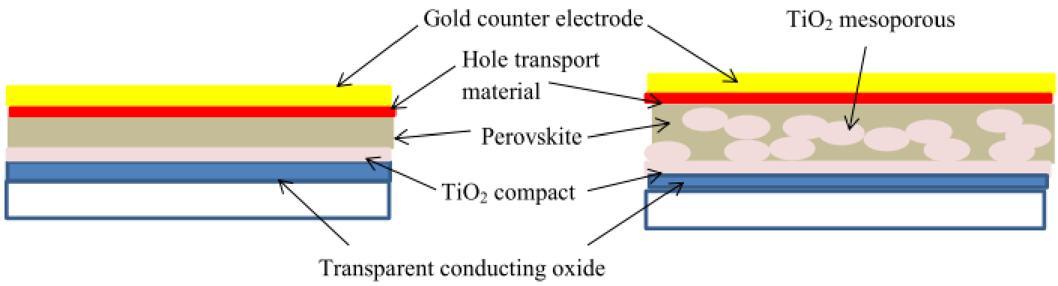
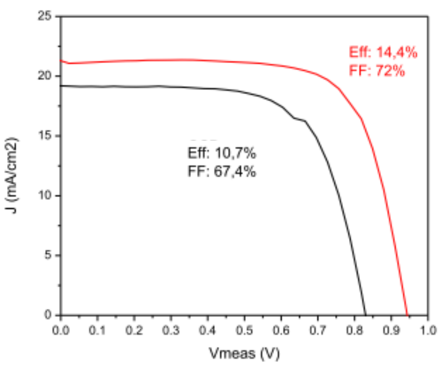


Fig. 1: LHS: Planar heterojunction perovskite cell architecture, RHS: Titania mesoporous perovskite architecture.



This work details examines the effect of temperature, concentration and composition on the viscosity of perovskite precursors and employs these materials in planar heterojunction and mesoporous perovskite cells. A detailed understanding of how these variables interact enables the properties of a perovskite ink to be tailored to the deposition process, enabling large area deposition without defects. Controlling the crystallisation of perovskite after deposition is also critical to ensure good coverage whilst minimising surface roughness. By controlling crystallisation 100% coverage of the perovskite layer can be achieved ensuring a device with high performance, Fig 2.

Fig. 2: red curve: 14.4% photo conversion efficiency with optimum perovskite coverage, black curve: 10.7% photo conversion efficiency with reduced perovskite coverage. Measured under standard test conditions, AM1.5 1000W/m^2.

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