**Solution-less Perovskite Photovoltaics: from the nanoscale to industrial scale**

*Timothy W. Jones,1 Kenrick F. Anderson,1 Jacob (Tse-Wei) Wang,1 Terry Yang,1 Benjamin C. Duck,1 Noel W. Duffy,2 Gregory J. Wilson1\**

*1 CSIRO Energy, Solar Technologies, Newcastle Energy Centre, NSW Australia*

*2 CSIRO Energy, Solar Technologies, Clayton Laboratories, VIC Australia*

**Abstract**

****Perovskite materials continue to generate significant interest from academia and industry as a potential component in next-generation, high-efficiency, low-cost, photovoltaic (PV) devices with record efficiency reports for champion devices now more than 22%. However, due to their complex dynamic chemistry of formation, the *process* of forming a uniform, consistent and stable perovskite coating is a challenge – especially for commercial applications.

Schematic of CSIRO Solution-less perovskite photovoltaics

The field of perovskite solar cells (PSCs) is rapidly maturing and developments are progressing at an impressive rate. Current state of the art lead-salt derived PSCs has seen efficiencies exceeding 24.2%  for 0.1 cm2 and 20.9% for >1 cm2 research grade devices. [1] It is well known that for enhanced performance of PSCs, control of the perovskite crystal formation via deposition and annealing conditions has been the fundamental to improving device performance.

In this talk we present a method for solution-less deposition to form perovksite semiconductors by a relevant industrial method – atmospheric chemical vapour deposition – thus reducing a barrier for commercialisation: lateral scale-up. Here we successfully demonstrate perovskite formation utilising a metallic seed layer, which can be readily deposited at large scale. The photoactive perovskite semiconductor is obtained through tuning the chemistry of intermediate structures to provide facile and uniform crystalline materials. We report a novel approach for rapid and uniform coverage and an easily tuned final morphology throgh a novel nucleation and crystallisation process to achieve uniform coverage with an optimal perovskite crystal morphology. This talk will outline our process and progress to date on research grade, and larger, devices.

**References**

1. Green, MA, Dunlop, ED, Levi, DH, Hohl‐Ebinger, J, Yoshita, M, Ho‐Baillie, AWY. Solar cell efficiency tables (version 54). *Prog Photovolt Res Appl*. 2019; 27: 565– 575. <https://doi.org/10.1002/pip.3171>