Contribution ID: **62** Type: **Parallel talk**

Evaporated Perovskite Solar Cells

Friday 6 November 2020 12:30 (20 minutes)

Humanity is faced with many global challenges, two crucial challenges are climate change and the growing demand for energy, especially in previously underserved regions of the world. One technology that helps address both of these challenges are photovoltaic solar cells. To speed up the widespread utilization of photovoltaics (PV) the efficiency of solar cells needs to rise further while the price needs to continue to decrease. The current industry standard are silicon solar cells. These are an established technology which reaches power conversion efficiencies (PCEs) of up to 27% and has seen a remarkable drop in retail price over the last five years. Silicon solar cells are reaching a limit and future improvements will be hard to come by. A promising new type of solar cells is based on hybrid organic-inorganic perovskite materials. These have attracted a lot of research interest as they are a highly promising and versatile group of materials. On the lab scale perovskite solar cells have reached record efficiencies of 25.3% on their own and 29.1% in a tandem solar cell together with silicon. Perovskite materials can be processed with much less energy input than silicon and can be integrated into flexible solar cells as well as applications beyond PV including LEDs and transistors. This makes them a highly interesting group of semiconductors which could form the basis for the next generation of solar cells and other optoelectronic devices. My research focuses on the fabrication, characterisation and optimisation of perovskite thin-films via co-evaporation in vacuum. Co-evaporation is a promising techniques as it is solvent free, fully additive, scalable and offers a high degree of control over the thickness and composition of the film. I will particularly focus on novel materials realised with co-evaporation [1] and the influence of impurities on the deposition process [2].

[1] Borchert, J., Milot, R. L., Patel, J. B., Davies, C. L., Wright, A. D., Martínez Maestro, L., ⋯Johnston, M. B. (2017). Large-Area, Highly Uniform Evaporated Formamidinium Lead Triiodide Thin Films for Solar Cells. ACS Energy Letters, 2(12), 2799–2804. https://doi.org/10.1021/acsenergylett.7b00967
[2] Borchert, J., Levchuk, I., Snoek, L. C., Rothmann, M. U., Haver, R., Snaith, H. J., ⋯Johnston, M. B. (2019). Impurity Tracking Enables Enhanced Control and Reproducibility of Hybrid Perovskite Vapor Deposition. ACS Applied Materials & Interfaces, 11(32), 28851–28857. https://doi.org/10.1021/acsami.9b07619

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Session Classification: Talks from participants: New Materials (de/engl)