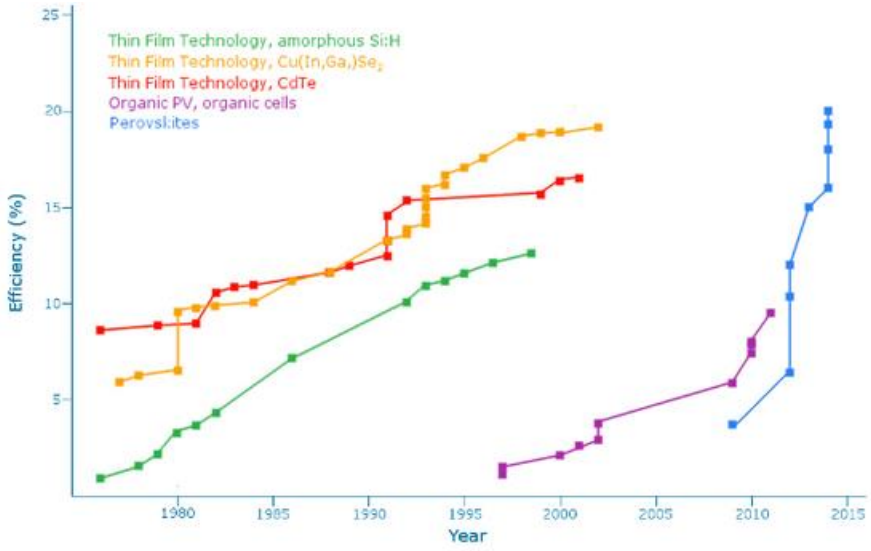
Kurt J Lesker Enables World Class Vapour Deposited Perovskite Solar Cell Research

Solar cells work by using materials that absorb photons from sunlight in a broad spectral range and in turn effectively convert this captured light into free charges that produce electricity. Modern solar cells are based on crystalline Silicon (c-Si) which is a cheap and abundant semiconductor, however the cost to produce electricity using them is relatively high as the efficiency rates of c-Si based cells are relatively low. As a result thin film solar cells have been developed to combat crystalline Silicon's inherent inefficiencies. Technologies such as CIGS, CdTE, amorphous Silicon and OPV have all strived to create solar cells that have high efficiencies coupled with good cell stability and low manufacturing costs. However there is a new type of material that has the potential to revolutionize the field of photovoltaics: perovskite structure based materials. A perovskite structure is any material with the formula ABX_3 and it is the recent work centred on organometal halide perovskites that has recently generated a feel good factor in the solar energy world and Kurt J Lesker has been at the centre of the key research in driving this exciting technology forward.

The ideal solar cell should have high carrier mobility necessary for charge extraction coupled with a wide spectral absorption range. In the past it is has been difficult to get both facets using existing materials, however perovskite structures have been found to strike a workable balance between the two requirements. Furthermore, breakthrough research led by Professor Henry Snaith[(a)] in the Department of Physics at the University of Oxford, UK using a Kurt J Lesker Mini SPECTROS™ has shown that vapour deposited perovskites can be produced with a higher level of crystallinity versus solution processed methods so that perovskites solar cells can now compete effectively with existing thin film cell technologies (see graph below). It is this major step in the evolution of perovskite solar cells that was reported in the esteemed journal Nature: http://www.nature.com/nature/journal/v501/n7467/full/nature12509.html



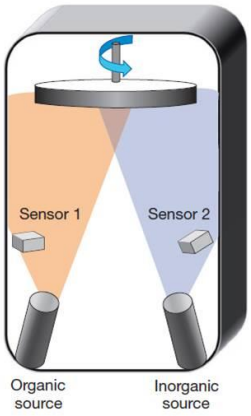
Perovskite Solar Cell Efficiencies vs Existing Technologies

The Mini SPECTROS™ is a versatile glovebox-interfaced perovskite vapour deposition system that uses proprietary Kurt J Lesker eKLipse™ software to accurately control Kurt J Lesker low temperature evaporation (LTE) sources. These sources are ideal for the deposition of perovskite materials. The Mini SPECTROS™ provides the researcher with very precise evaporation/deposition rate control and an accurate material doping level in co-deposition mode which results in very high film uniformity and homogeneity that is important for perovskite device manufacture. Kurt J Lesker also offers gloveboxes to integrate to the Mini SPECTROS™ along with glovebox accessories such as spin-coaters, hot-plates and solar-simulators. (https://www.lesker.com/newweb/vacuum_systems/deposition_systems_pvd_mini_spectros.cfm) http://www.lesker.com/newweb/vacuum_systems/deposition_systems_pvd_spectros.cfm.

Henry Snaith's group collaborated with the research group run by Professor Michael Johnson at Oxford, here shown pictured with Kurt J Lesker staff in photo (b) and Mingzhen Liu (Snaith's and Johnson's joint student) looked at the thin film structure of [TiO_2/$CH_3NH_3PbI_3$/OmeTAD] and used the Kurt J Lesker Mini SPECTROS™ system to co-deposit the precursor salts of CH_3NH_3I and $PbCl_2$ from two LTE sources (see set-up below) to deposit the perovskite layer of $CH_3NH_3PbI_{3-x}Cl_x$ and create a record breaking 330nm thick perovskite device[(c)] which exhibited an efficiency of 15.4%. This

figure places vacuum deposited perovskite well and truly amongst existing solar cell technologies. Henry Snaith predicts that in the next 5 years efficiency figures of >20% will be possible with perovskites.

Kurt J Lesker Mini SPECTROS™ Perovskite Vapour Deposition System (glovebox not shown)



Kurt J Lesker Mini SPECTROS™ Perovskite Co-deposition Chamber Layout

Speaking of the Mini SPECTROS™ and working with Kurt J Lesker, Henry Snaith commented:

"The Mini SPECTROS has proven to be the ideal tool for rapidly proving out the feasibility of vapour deposited perovskite solar cells, the combination of organic and metal sources offers great versatility for investigating new materials with a broad range of deposition temperatures. The prompt and friendly service offered by Lesker has also helped us to get the most out of this tool" – Professor Henry Snaith, University of Oxford

The benefits of vapour deposited perovskites using the Mini SPECTROS™ are touched on in the Nature paper;

"Dual-source vapour deposition results in superior uniformity of the coated perovskite films over a range of length scales, which subsequently results in substantially improved solar cell performance"

"A distinct advantage of vapour deposition over solution processing is the ability to prepare layered multi-stack thin films over large areas"

"Vapour deposition can lead to full optimization of electronic contact at interfaces through multilayers with controlled levels of doping"

"..with vapour deposition the charge-collection interfaces can be carefully tuned, and multi-junction architectures are more straightforward to realize"

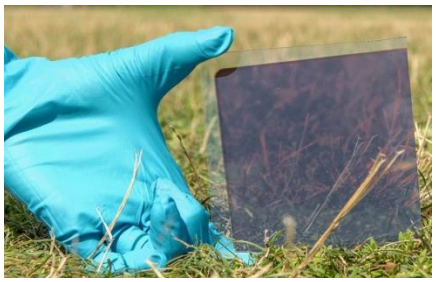
"..because vapour deposition of the perovskite layers is entirely compatible with conventional processing methods for silicon wafer-based and thin-film solar cells, the infrastructure could already be in place to scale up this technology"

If you are interested in the vapour deposition of perovskite solar cells then Kurt J Lesker has the deposition system and glovebox for you. Please contact us to discuss your research needs – we look forward to hearing from you.

(a)

(b)

(c)



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