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RESEARCH HIGHLIGHT

The rise of the perovskites: the future of low cost solar photovoltaics?

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Lui *et al.*[1] report new 'perovskite-based' solar cells having a photon-to-electron-conversion-efficiency (PCE) of a remarkable 15.4%. Traditional photovoltaic technology is dominated by c-Si, with inorganic thin film entrants CdTe, CIS and GIGS making substantial market inroads. Pipeline technologies such as dye-sensitized solar cells (DSSCs) and organic solar cells (OSCs)[2] promise ultra-low manufacturing costs as well as light-weight, flexible modules. As yet, the 'pipeline' is yet to deliver commercial product with long-term stability and module-scale PCEs being hurdles. The perovskite technology emerged from DSSCs as *p*-type materials, and then as combinatorial replacements for the dye and hole-transport components.[3] In a series of rapid evolutionary steps, lead-perovskite solar cells have leapfrogged DSSC and OSC efficiencies (Figure 1). In the work of Lui *et al.*,[1] the authors compare two architectures that differ only in the processing of the perovskite active layer—solution or vacuum evaporation. They demonstrate the latter delivers more uniform, dense films leading to superior device performance and a new record efficiency, admittedly on a cell of only 0.07 cm^2. The perovskite layer in question was deposited by co-evaporation of lead(II) chloride and methylammonium iodide in a ratio of 1:4. The simple *p-i-n* heterojunction architecture consisted of the following: Ag(anode)/doped-spiro-OMe-TAD(hole-transport layer)/perovskite-330 nm (absorbing layer)/TiO2(*n*-type)/FTO(cathode). A feature of the perovskites in this configuration is a large open-circuit voltage (0.8–1.0 V) and the evaporated active layer delivers superior current and fill factor. An interesting observation—but why? The metal-organic perovskites are maybe the 'missing-link' between the worlds of inorganic and organic semiconductors. In the former, carriers are transported in a coherent superhighway with minimal loss. In the latter, disorder constrains the motion of charge to hopping between localized states, and low dielectric constants mean that photo-excitations remain 'Coulombically' bound (excitons). A PCE of 15.4% in simple perovskite thin film solar cells has attracted considerable interest, as they appear to combine the advantages of OSCs and DSSCs, with the performance of traditional inorganics. In the work of Lui *et al.*,[1] the authors claim the perovskite to be the absorbing active layer. The mechanisms by which carriers are generated and then transported to the electrodes are, however, not clear. Critical questions must be answered such as: are the devices excitonic? If so, what is the exciton diffusion length? What are the carrier lifetime and recombination dynamics? Two other recent letters published in *Science* provide some answers—both claim long hole and electron diffusion lengths.[4,5] In conclusion, while the photophysics and transport physics are still unclear, and issues relating to toxicity, scaling and stability are unresolved, the rapid improvement in perovskite-based solar cells means they cannot be ignored, and what is more they may well put OSCs and DSSCs in the shade!

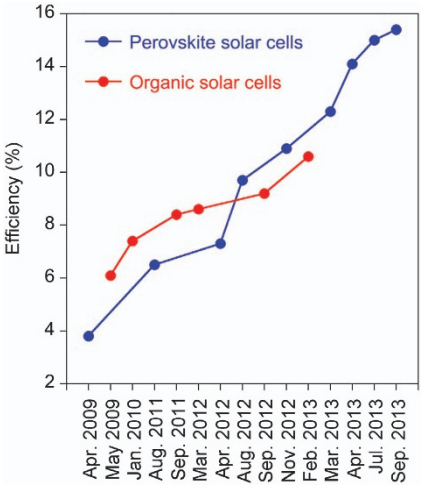

Figure 1 Comparison of organic solar cell and perovskite device efficiencies over a similar timeframe.

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