Summary of key finding and importance of results

Limitations in scope and remaining questions

Scientific/engineering implications of this work

The results presented here demonstrate that solid perovskite layers can operate extremely well in a solar cell, and in essence set a lower limit of 330 nm (the film thickness) on the electron and hole diffusion length in this perovskite absorber. However, more work is required to determine the electron and hole diffusion lengths precisely and to understand the primary excitation and the mechanisms for free-charge generation in these materials.

A distinct advantage of vapour deposition over solution processing is the ability to prepare layered multi-stack thin films over large areas. Vapour deposition is a mature technique used in the glazing industry, the liquid-crystal display industry and the thin-film solar cell industry, among others. Vapour deposition can lead to full optimization of electronic contact at interfaces through multilayers with controlled levels of doping[20], as is done in the crystalline silicon 'heterojunction with thin intrinsic layer' solar cell[21] and in thin-film solar cells[3]. Additionally, organic light-emitting diodes[22,23] have proved to be commercially sound, with devices with extremely thin multilayer stacks fabricated by vapour

deposition. Small molecular organic photovoltaics have also been able to compete directly with solution-processed organic photovoltaics despite much lower levels of research and development, because with vapour deposition the charge-collection interfaces can be carefully tuned, and multi-junction architectures are more straightforward to realize[24]. An interesting possibility for the current vapour-deposited perovskite technology is to use it as a 'top cell' in a hybrid tandem junction with either crystalline silicon or copper indium gallium (di)selenide. Although ultimately an 'all-perovskite' multi-junction cell should be realizable, the perovskite cells have now achieved a performance that is sufficient to increase the absolute efficiency of high-efficiency crystalline silicon and copper indium gallium (di)selenide solar cells[25]. Additionally, 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.

Suggestions for further investigation

Forward-looking statement about the field and how this work will facilitate deployment of technology