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Ten Years' Glory of Halide Perovskite Materials

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More than half century, crystalline silicon solar cells struggle to reach over 20% power conversion efficiencies (PCEs). Still, the complex procedures in industry escalate its payback time. Copper indium gallium selenide (CIGS) and cadmium telluride (CdTe), shows more than 19 % PCE for 1 cm^2 cells, and they used to be a promising second-generation thin-film solar cells.[1] However, they are facing difficulties in rare elements and large-scale production.[2]

When it was first reported in 2009 with less than 4% PCE,[3] scientists would never think perovskite type $CH_3NH_3PbX_3$ solid solar cells can reach PCE over 25%,[4] in barely 10 years. The astounding progresses achieved in the past 10 years suggests that it is a better candidate for the next generation solar cells.[5-11]

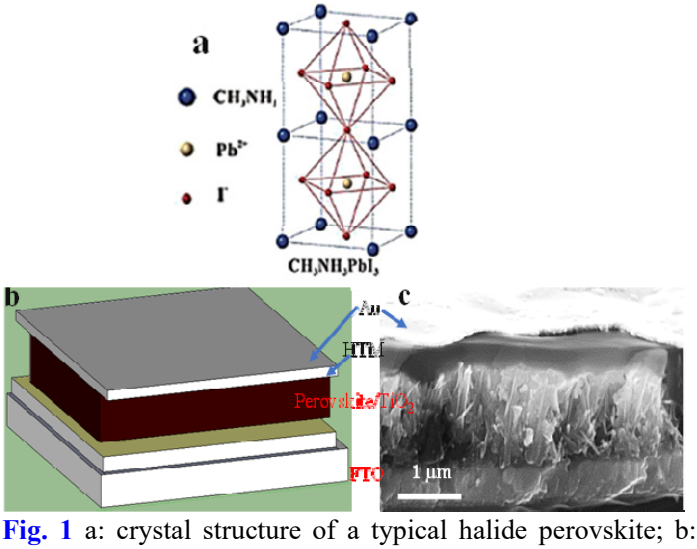

Fig. 1 a: crystal structure of a typical halide perovskite; b: solar cell structure diagram; c: SEM cross-section image.

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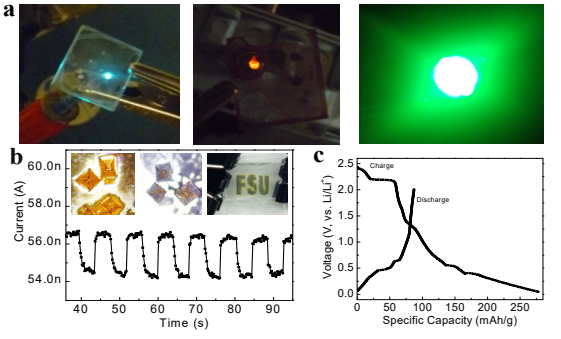

Fig. 2 a: different light emitting color from halide perovskite materials; b: electrochromism discovered on halide perovskite material; c: ion battery charge and discharge curves based on halide perovskite material.

Halide perovskites material is a typical ABX_3 crystal. A is organic cation, such as $CH_3NH_3^+$ (MA), $CH(NH_2)_2^+$ (FA), $C_6H_5(CH_2)_2NH_3^+$ (PEA); or, A can be inorganic cation, such as Cs^+. B is metal, such as Pb^{2+} or Sn^{2+}. X is halide or pseudohalide, such as I^- , Br^-, Cl^- and SCN^-.[12-14] Halide perovskite materials show excellent performance in carrier generation, charge diffusion and light absorption. Plus, wet chemistry is the main method, which can make halide perovskite solar cells cheap and easy to produce. Fig. 1 shows the crystal structure of a typical halide perovskite $CH_3NH_3PbI_3$ and the cross-section structure of halide perovskite solar cell.

The fever for of halide perovskite materials in solar cell is not over yet, the halide perovskite materials started to attract scientists' attention in other areas already.

Few years after the application in solar cells, various of other interesting applications of halide perovskite materials have been discovered in light emitting,[15-18] sensor/detector,[19-21] field effect transistor,[22,23] and others.[24] Energy storage become more and more important is our daily life, such as supercapacitors and lithium ion batteries.[25-27] As researches carrying on, especially doping and intercalation, a new world for halide perovskite materials emerges. Figure 2 shows some results of different colors

light emitting, ion battery and electrochromism based on halide perovskite materials.[28] Of course, here is just part of the story.

Modern technologies have widened the vision of human wider than any time in the history: nanomaterials have never get so close to us before, from computer chips to targeting medications;[29,30] with the advanced instrumentations to visualize the nano-world,[31] we have seen the most amazing and beautiful science ever. What else surprises halide perovskite materials can give us in the next 10 years?

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