A new self-adhesive transparent electrode for high efficiency perovskite solar cells

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Abstract:

Perovskite solar cells have made a dramatic entrance to the research arena already reaching 20% efficiency. A key step in enabling the large scale manufacture of perovskite solar cells is the development of a low cost flexible transparent electrode that can be easily applied in a continuous process to replace the vacuum evaporated gold contact.

In laboratory devices charge collection is usually achieved through the evaporation of an opaque gold metallic contact onto the active material. This limits their potential for scale-up as the materials used are inherently expensive to use and deposit. Furthermore the standard architecture generally dictates that the working electrode of the cell must be transparent. Current solution processable electrodes employ silver nanowires that, although capable of making good electrical contact, can give rise to silver halide formation and degradation of performance.

Here we will describe an entirely new system which is a blend of an acrylic emulsion pressure sensitive adhesive (PSA) with a very low loading (0.018 volume fraction) PEDOT:PSS. This causes a phase segregation to occur between the PEDOT:PSS and the polymer adhesive domains which is advantageous for achieving conductivity at an order of magnitude lower volume fraction below conventional percolation threshold. The PEDOT:PSS assembles into a honeycomb arrangement around the larger domains typical of acrylic emulsion the spanning network is more ordered and allows conductivity to be evolved. The low loading gives excellent transparency of over 85%. To complete the electrode design the conducting adhesive is applied onto a corrosion proof Ni mesh electrode embedded into conventional PET film. The whole electrode can be fabricated separately to the perovskite material and then laminated together at room temperature providing transparency, protection and efficient conductivity.

Device performance is comparable to that of a gold vacuum deposited electrode with champion efficiencies achieving 16.7% for the gold and 15.5% for the laminate on a glass substrate. We will also demonstrate flexible indium and silver free perovskite solar cell using metal foil as a substrate incorporating the new laminate with an efficiency exceeding 10%.