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Interface Engineering in Solution-Processed Optoelectronics

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A key feature of organic devices, which emerged from early organic LED and photovoltaic research, is that internal interfaces are relatively benign - i.e. they are not intrinsically associated with gap states or tunneling barriers. The same seems to be true for new classes of solution-processed semiconductors such as the organometal-halide perovskites. Engineering of interfaces can therefore be achieved using a remarkably wide range of materials, though the mechanism isn't always clear.

Here we show the importance of understanding the behavior of interfacial materials by comparing two key examples. We show how spatial atmospheric atomic layer deposition can be used as a powerful, scaleable technique to form robust oxide electrodes at near room temperature, and how this can be used to precisely control interface conductivity and energetics through variable doping. By rational interface design, we are able to significantly improve performance in a range of optoelectronic devices, including quantum dot solar cells and perovskite LEDs.

Using the example of water and alcohol-soluble polymer interlayers, we also show why device engineers must be careful to understand exactly how our choice of interface affects the rest of a device. We show how significant work function modification, charge-trapping and chemical modification in organic devices may be caused by non-solvent treatment alone, irrespective of the presence of the interlayer. As such, we show how apparently simple device modification can have effects far beyond those initially intended – attempting rational materials design doesn't automatically exclude the irrational and fortuitous.

Keywords: Organic; Perovskite; Interface; Oxide; Optoelectronics