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Emplate-Assisted Coating Strategy for Fabricating Large-Area Perovskite Single Crystal Arrays

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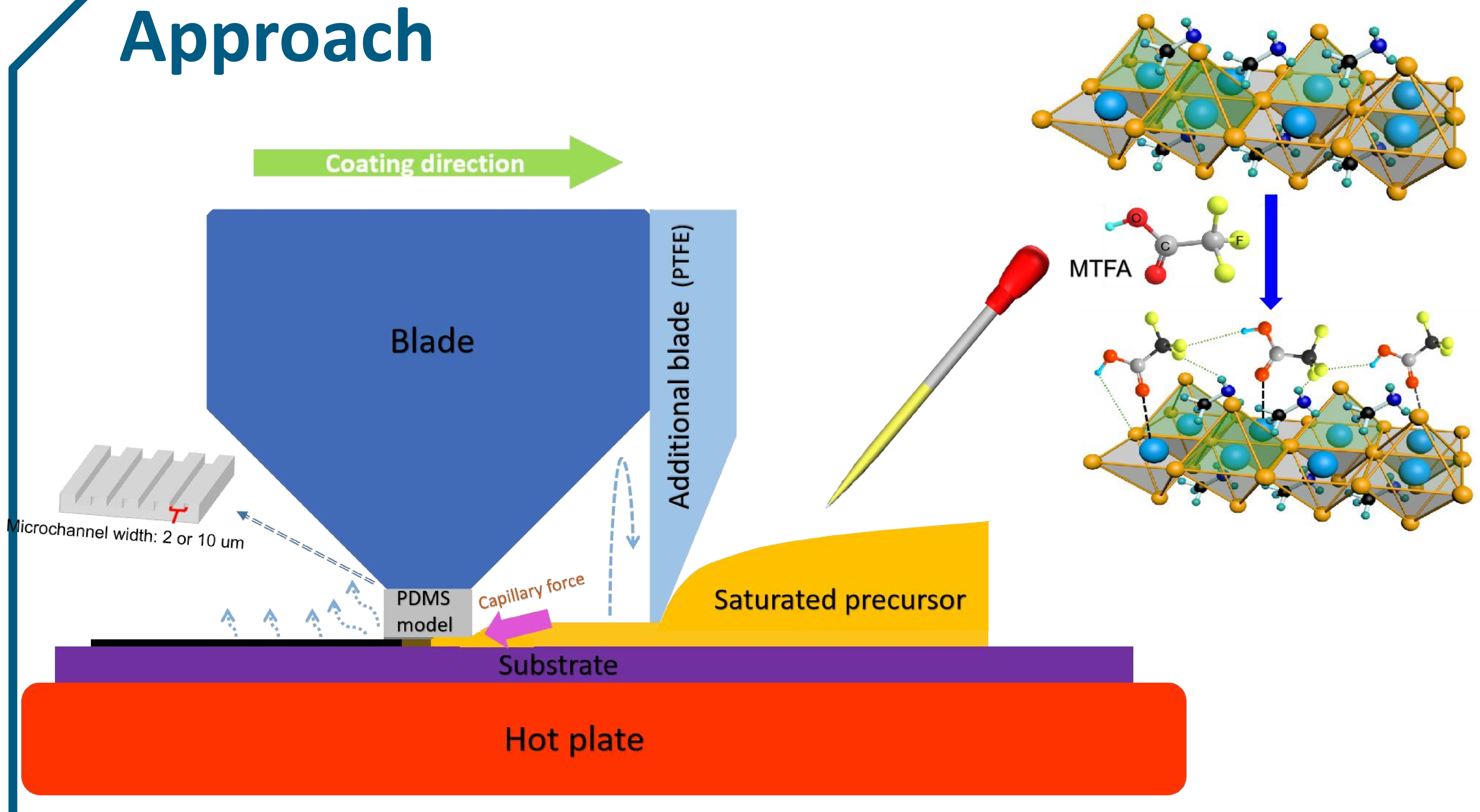
Motivation

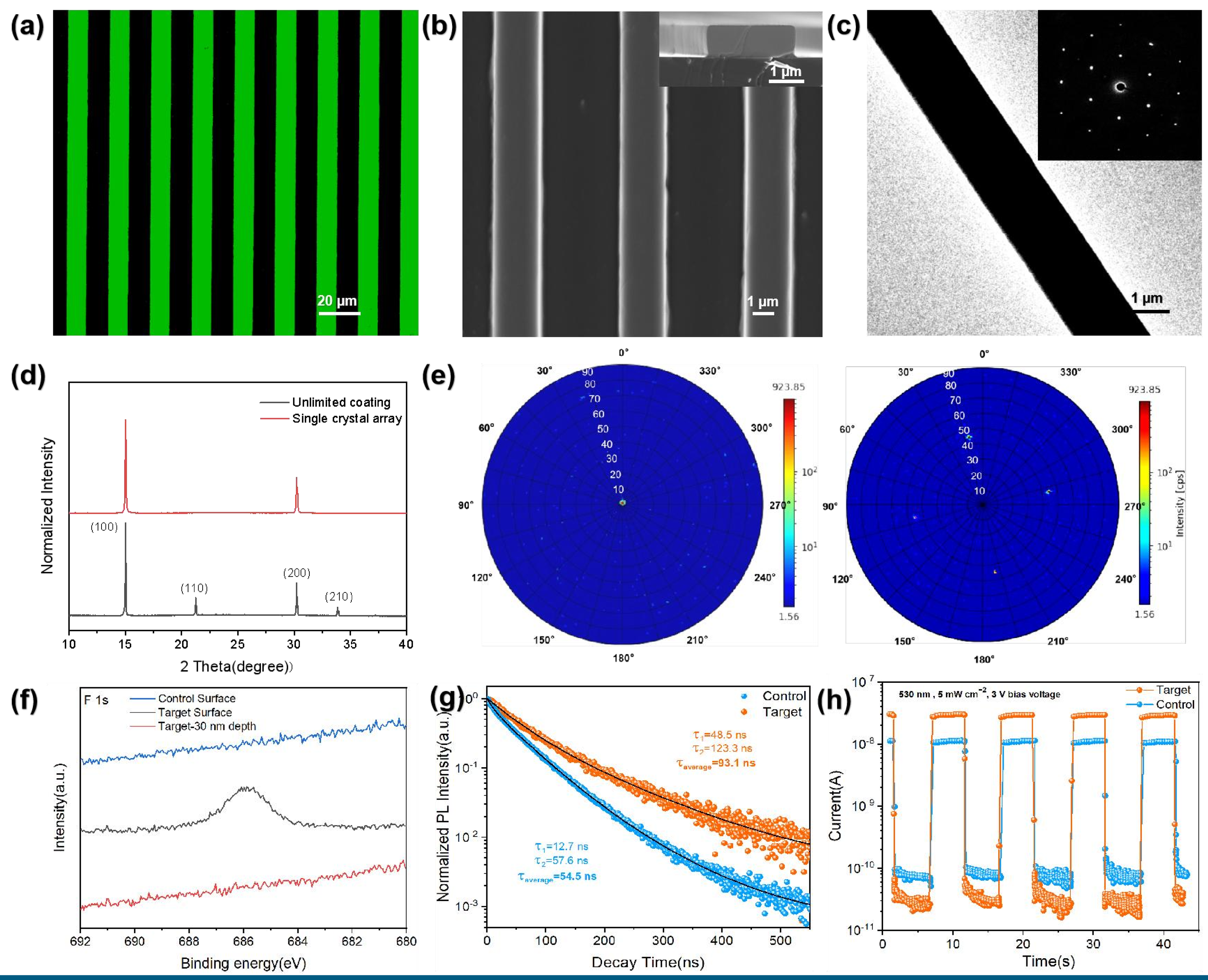
- Among various solution-based methods, blade coating has the advantages of high throughput, roll-to-roll, and minimal material wastage. However, it still remains a great challenge to achieve large-area growth of PSCs with highly uniform morphology via blade coating.[1]
- One-dimensional OIHP structures, such as micro/nanowires with higher crystalline quality and fewer grain boundaries, are considered as promising alternatives to thin films to improve the performance of OIHP-based photodetectors[2]. However, a concomitant disadvantage is their large surface area to volume ratio. This means that surface defects cannot be ignored[3].
- Therefore, how to combine the advantages of coating and perovskite single crystal arrays while solving their inherent problems is an extremely complex and interesting topic.

Approach



- The combination of modified PDMS prepared based on photoresist templates and coating methods can get rid of the dependence on the shape and size of the substrate.
- MTFA, a fluorine-containing additive can be used to reduce surface defects. On the other hand, the contact angle of the precursor liquid on the substrate can be slightly increased to improve the continuity of the single crystal array.

Results



a) Fluorescence micrograph of large-area 1D perovskite single-crystal arrays.

b) Top and cross section SEM images of the perovskite crystals fabricated by spatial confinement crystallization strategy.

c) TEM image of an individual perovskite microwire with smooth surface and straight boundary and SAED pattern.

d) XRD pattern of single-crystal arrays.

e) XRD pole figure measurements along the (100) and (110) direction of the $MAPbBr_3$ single-crystal arrays.

f) The depth profile XPS spectra of treated $MAPbBr_3$ single-crystal arrays.

g) Decay transient comparison between control and MTFA treated $MAPbBr_3$ single-crystal arrays at the same test conditions.

h) Transient photocurrent response for the $MAPbBr_3$ single-crystal array photodetector at a 3 V bias.

Conclusion

- First, we designed for the first time a new, efficient, and low-cost method for preparing single crystal arrays based on blade coating.
- Second, the method is universal not only to coating materials but also to substrates.
- Third, the one-step precursor solution modification method can not only passivate surface defects but also improve the long-term stability of the array. More importantly, we used DFT calculations to clarify the source of defects and the work mechanism of MTFA.
- Fourth, in terms of performance, compared with similar articles, our $MAPbBr_3$ single crystal array currently has the lowest defect concentration. Therefore, we are very much looking forward to other parameter test results and long-term stability results of the photodetector.

References

[1] *W. Deng,* et al.*, Adv. Mater. 2020, 32, 1908340.*

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[3] *L. Gao,* et al.*, Nano Lett.* 2016, 16, 7446–7454

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