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Nanoimprint Lithography-Dependent Vertical Composition Gradient in Pseudo-Planar Heterojunction Organic Solar Cells Combined with Sequential Deposition

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Abstract

- **Background:** Although suitable vertical phase separation morphology in organic solar cells (OSCs) can be obtained by the donor/acceptor sequential deposition (SD) method, the lack of precisely adjusting vertical composition gradient and molecular crystallinity is a key limitation.
- **Idea:** Nanoimprint lithography (NIL) combined with SD dual-functionalized regulation strategy is first used to fabricate high-performance pseudo-planar heterojunction (PPHJ) OSCs, which is conducive to constructing vertical bi-continuous donor/acceptor network to provide sufficient charge separation interface area and orderly charge transport channels.
- **Conclusion:** PM6 donor with regular periodic nanograting structure and improved crystallinity is formed via NIL, effectively avoiding the erosion problem ascribed from the subsequent depositing of the Y6 acceptor. And the best-imprinted device enables a power conversion efficiency as high as 17.36%, which is higher than the control SD-based device (15.46%).

Result and Discussion

Experimental process

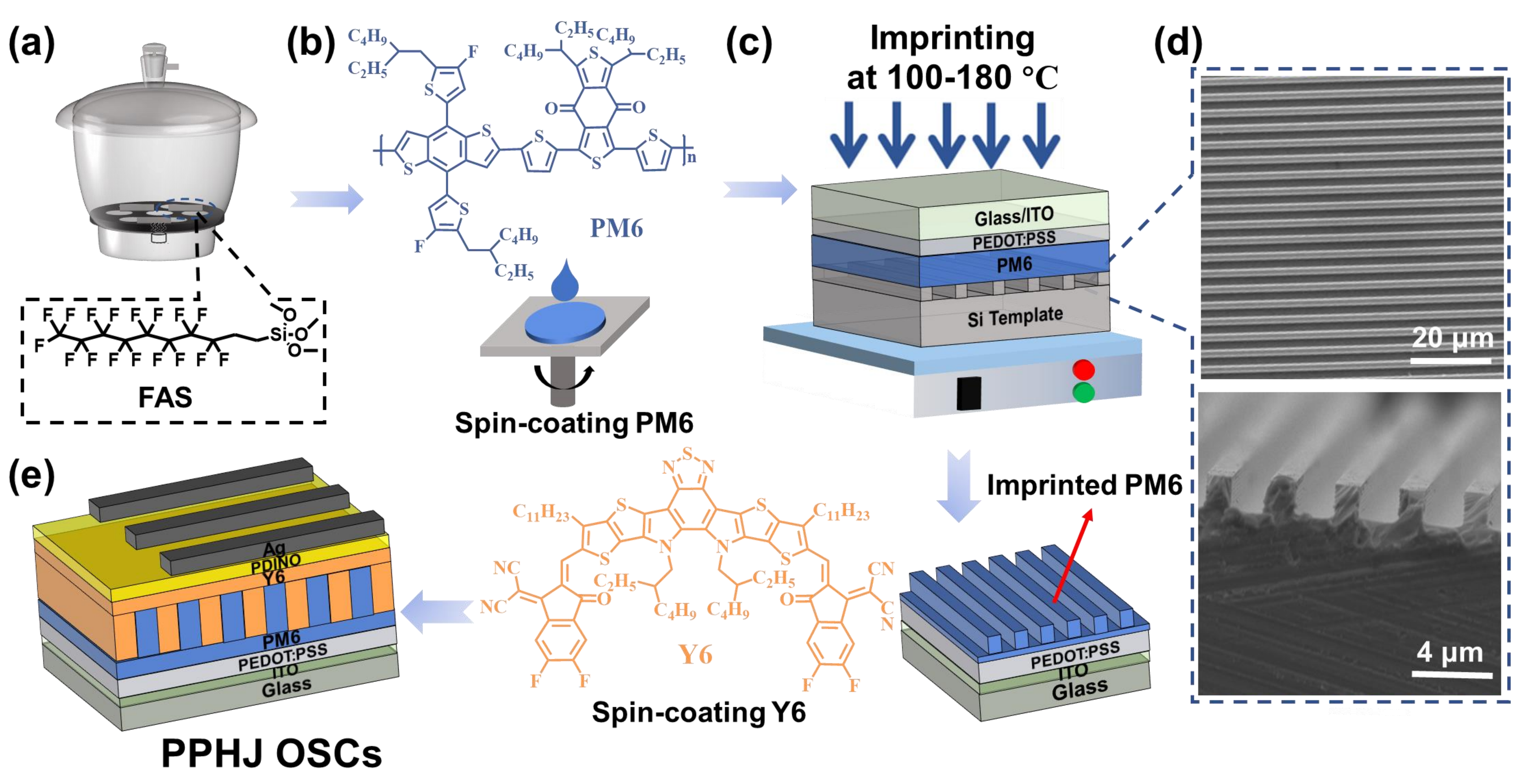

Fig 1. Flow chart of the entire nanoimprint experiment.

- The planar and cross-sectional scanning electron microscope (SEM) images of the template were perfectly transferred onto the PM6 film by NIL under the control of temperature and pressure. Then, the PPHJ device is constructed by depositing Y6 on the imprinted PM6.

Optical characterization

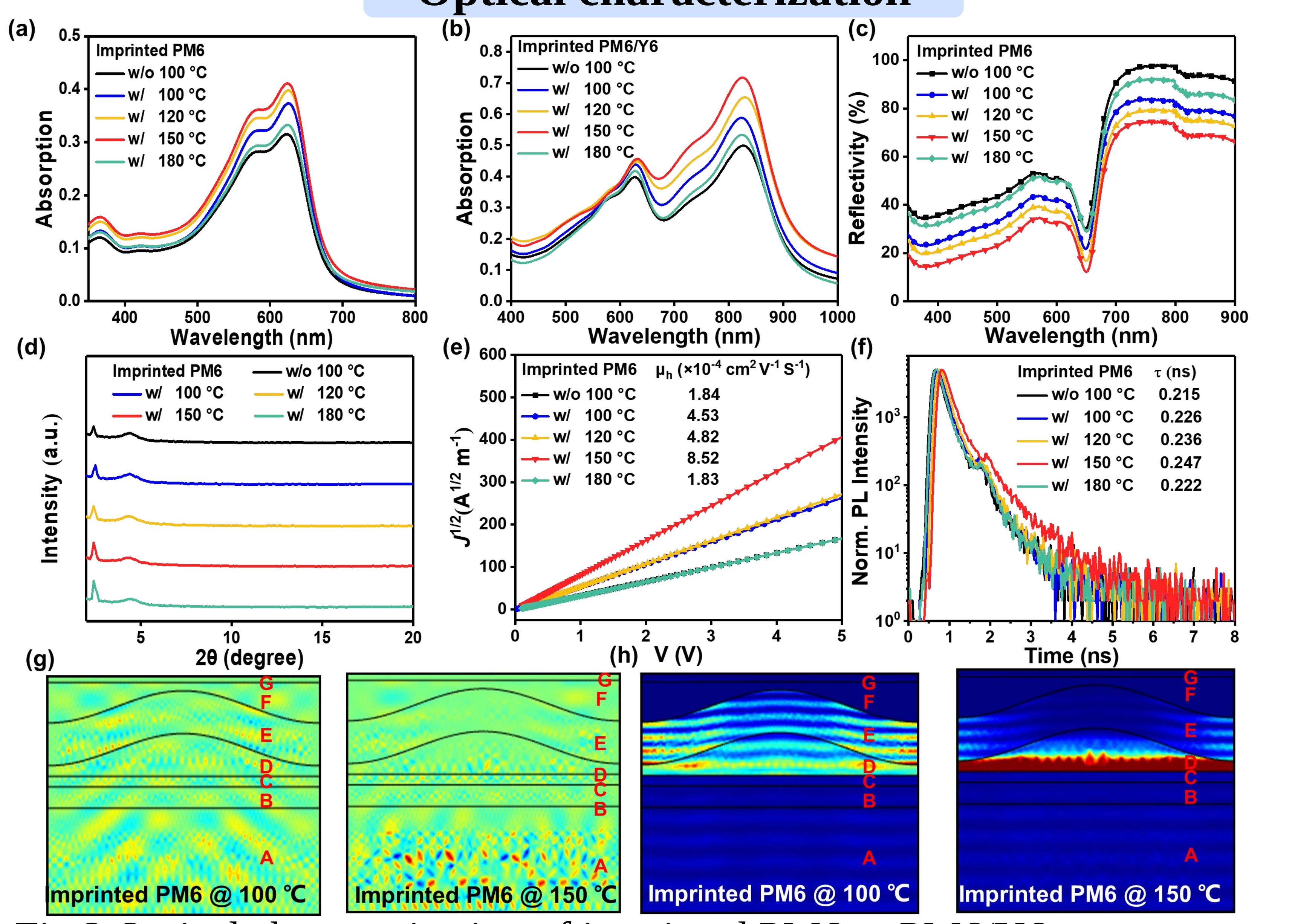

Fig.3 Optical characterization of imprinted PM6 or PM6/Y6

- NIL strategy can construct vertical bi-continuous D/A network with superior contact area and directional charge transport channels
- Raise the light utilization and boost the excitons diffusion/transmission

Morphology characterization

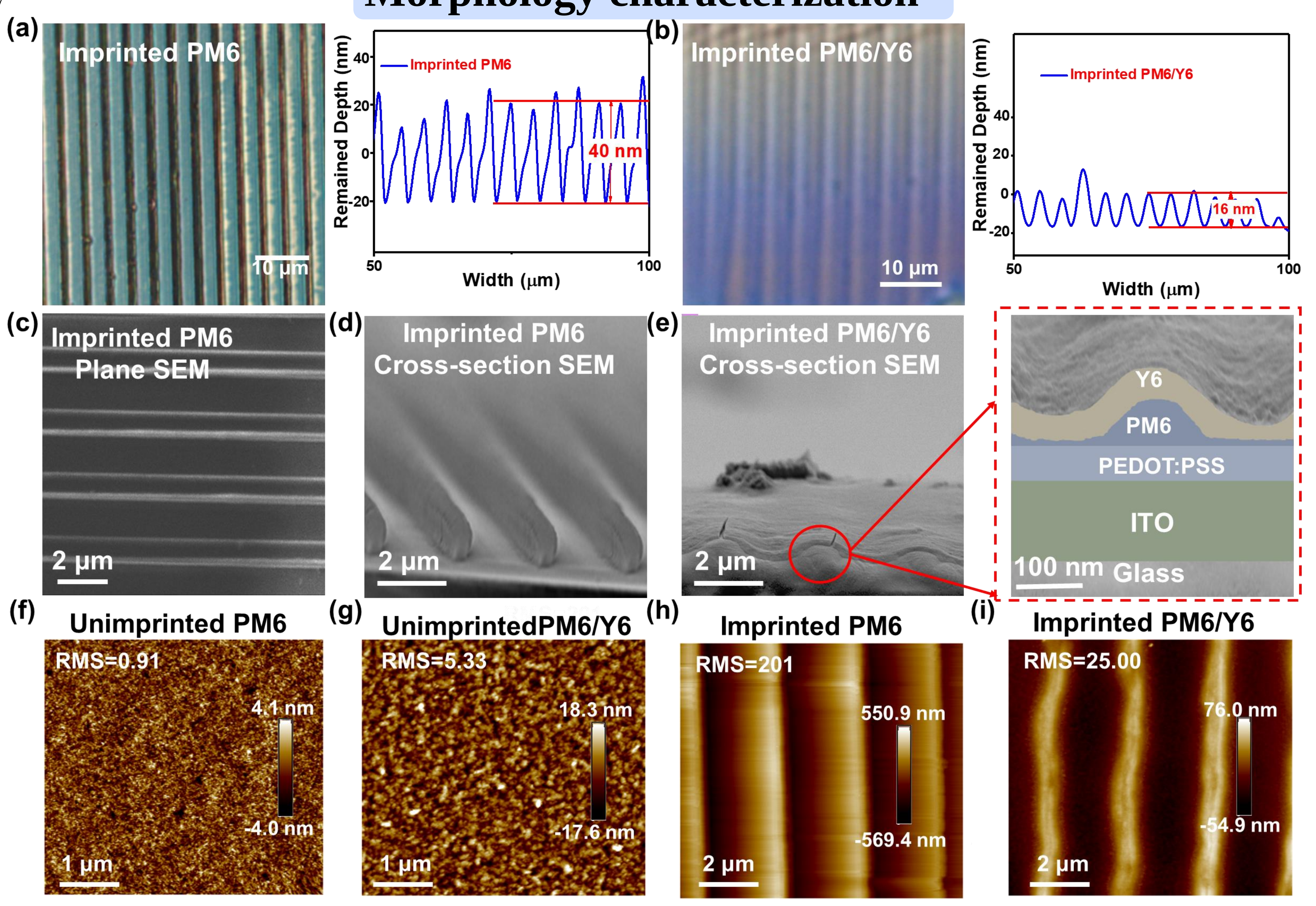

Fig 2. Optical microscope images, SEM images, AFM images and phase diagrams

- Nanograting can be gained and the generated larger contact area can facilitate exciton dissociation.

Device performance characterization

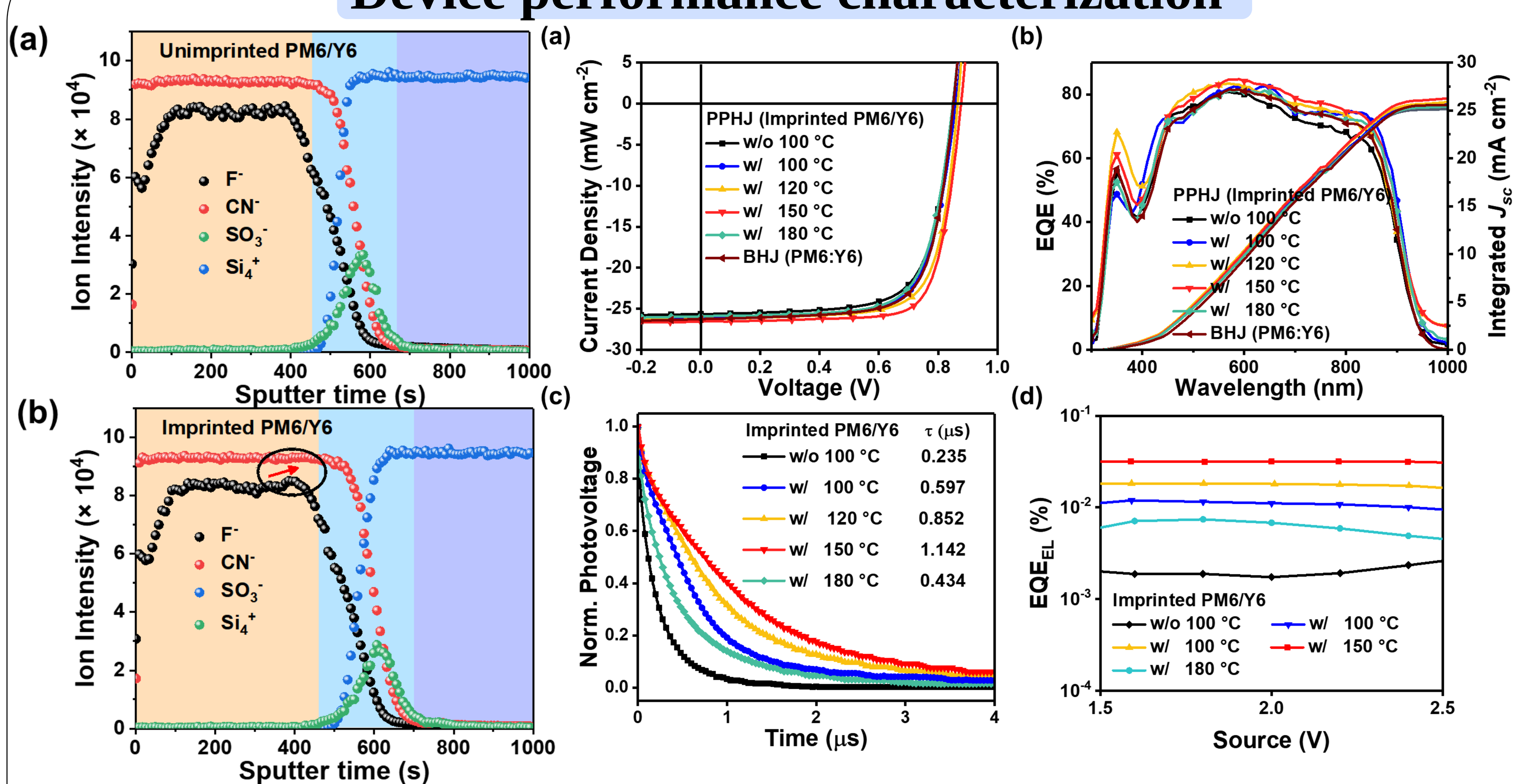

Fig.4 ToF-SIMS depth profiles Fig.5 Device performance characterization

- ✓ NIL can regulate the contact area and vertical distribution of D/A
- ✓ NIL can promote charge transmission/collection and reduce the non-radiation loss and lead to high-performance PPHJ OSCs.

NIL/SD method is a promising process to endow the vertical phase separation morphology for achieving superior device performance.

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