Patterned Wettability Induced Growth of Perovskite Nanowire Arrays

Guannan Zhang, Zhao Sun, Chuwei Liang, Liyang Chen, Wen-Di Li
Department of Mechanical Engineering, Univ. of Hong Kong, Hong Kong
liwd@hku.hk

Due to their unique properties including tuneable band gaps, superior carrier mobility, high color purity, high absorption and emission efficiency, halide perovskites have been widely used in various kinds of optoelectronic applications such as photodetectors, PeLED, laser, etc. [1-2] Specifically, low-dimensional perovskite nanostructures such as nanowires have attracted extensive attention due to their excellent optical, electrical, and stability characteristics, as compared to continuous film materials. [3] Ensuring the size uniformity and controllability of perovskite nanostructures is a prerequisite for their adoption in practical device applications. Diverse methods, such as inkjet printing, spin coating, vapor phase growth, blade coating, and slot-die coating, have been applied to fabricate low-dimensional perovskite nanostructures. However, these methods are usually achieved by utilizing nano-templates, which increases the complexity and cost of the fabricating process. Besides, ensuring uniform morphology and good crystallization is also very challenging to achieve high-performance perovskite nanostructures.

Herein, a template-free fabrication method to realize the controllable growth of perovskite nanowire arrays via the inducement of patterned wettability is demonstrated. Figure 1 shows the schematics of perovskite nanowires fabrication strategy. The hydrophilic-hydrophobic nanograting structure is constructed by interference lithography and trichloro(1H,1H,2H,2H-perfluorooctyl)silane (FTDS) treatment. Then, perovskite nanowires can be fabricated by high-throughput blade coating.

In order to avoid obtaining perovskite structures with discontinuous morphology and low crystallinity, we adjust blade coating parameters (i.e., blade gap, velocity, and temperature) and the solvent properties, particularly the viscosity. By utilizing the optimized process parameters obtained, $MAPbI_3$ perovskite nanowire structure with uniform dimension and excellent crystallization can be obtained, as shown in Figure 2. In addition, this method can be used to prepare diverse perovskite nanowire arrays, such as $CsPbBr_3$ nanowires. The strategy shows a facile method to fabricate perovskite nanowire arrays, paving the way to low-cost, large-area, and rapid fabrication of high-performance perovskite optoelectronic devices.

[1] W. Deng, J. Jie, X. Xu, Y. Xiao, B. Lu, and X. Zhang, *Adv. Mater*. **32**(16), 1908340 (**2020**).
[2] Z. Zhang, F. Vogelbacher, J. De, Y. Wang, Q. Liao, Y. Tian, and M. Li, *Angew. Chem. Int. Ed* **61**(34), e202205636 (**2022**).
[3] S.Chu, W. Chen, Z. Fang, X. Xiao, Y. Liu, J. Chen, and Z. Xiao, *Nat. Commun.* **12**(1), 147 (**2021**).

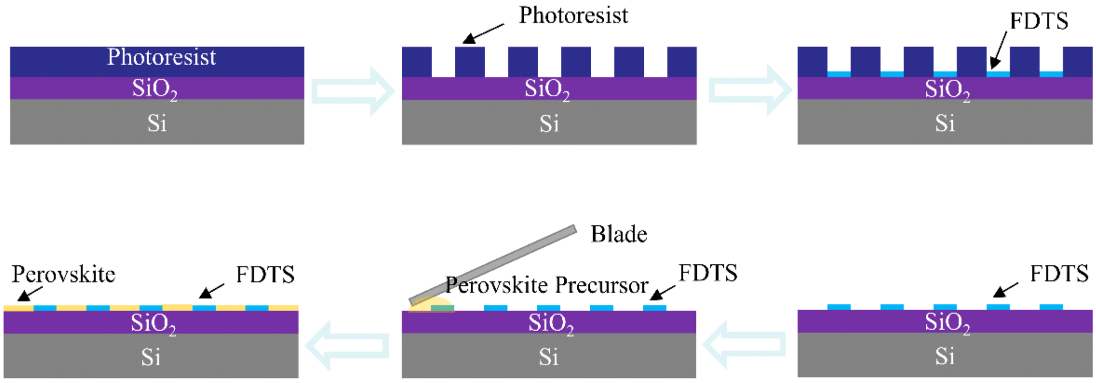

Figure 1: Schematics of perovskite nanowires fabrication strategy.

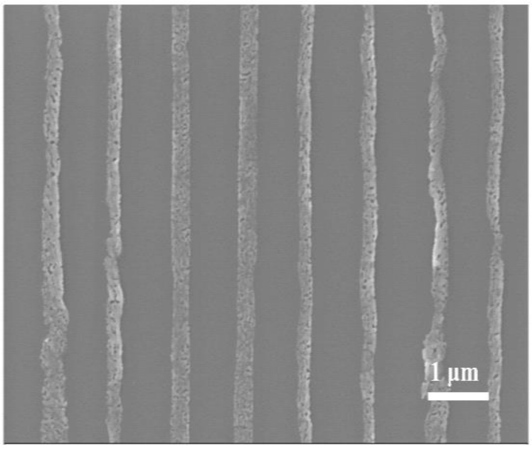

Figure 2: SEM image of perovskite nanowires fabricated by wettability-inducement and template-free blade coating strategy.