Surface-Guided Halide Perovskite Nanowires

Ernesto Joselevich
Department of Materials and Interfaces
Weizmann Institute of Science
ernesto.joselevich@weizmann.ac.il
http://www.weizmann.ac.il/materials/ernesto

The large-scale assembly of NWs with controlled orientation on surfaces remains one challenge toward their integration into practical devices. During the last few years our group reported the growth of perfectly aligned, millimeter-long, horizontal NWs of GaN [1], ZnO [2], ZnSe [3], ZnTe [4], CdSe [5] and other materials, with controlled crystallographic orientations on different planes of sapphire [1-5], SiC [6], quartz [7], and spinel [8]. The growth directions and crystallographic orientation of the NWs are controlled by their epitaxial relationship with the substrate, as well as by a graphoepitaxial effect that guides their growth along surface steps and grooves. As a proof of concept for future applications, we demonstrated the massively parallel self-integration of NWs into circuits via guided growth [9], and the bottom-up fabrication of nano-optoelectronic devices, including photodetectors [3-5] and photovoltaic cells [10].

Here we extend the surface-guided growth approach to halide perovskite nanowires [11]. All-inorganic lead halide perovskite nanowires have been the focus of increasing interest since they exhibit improved stability compared to their hybrid organic-inorganic counterparts, while retaining their interesting optical and optoelectronic properties. Arrays of surface-guided nanowires with controlled orientations and morphology are promising as building blocks for various applications and for systematic research. We report the horizontal and aligned growth of $CsPbBr_3$ nanowires with a uniform crystallographic orientation on flat and faceted sapphire surfaces to form arrays with 6-fold and 2-fold symmetries, respectively, along specific directions of the sapphire substrate. We observed wave-guiding behavior and diameter-dependent photoluminescence emission well beyond the quantum confinement regime. The arrays were easily integrated into multiple devices, displaying p-type behavior and photoconductivity. Photodetectors based on those nanowires exhibit the fastest rise and decay times for any $CsPbBr_3$-based photodetectors reported so far. One-dimensional arrays of halide perovskite nanowires are a promising platform for investigating the intriguing properties and potential applications of these unique materials.

References

[1] *Science* **2011**, *333*, 1003.
[2] *ACS Nano* **2012**, *6*, 6433.
[3] *Adv. Mater.* **2015**, *27*, 3999.
[4] *J. Phys. Chem. C,* **2016**, *120*, 18087.
[5] *ACS Nano* **2017** ,*11*, 213.
[6] *Nano Lett.* **2013**, *13*, 5491.
[7] *ACS Nano* **2014**, *8*, 2838.
[8] *J. Phys. Chem. C* **2014**, *118*, 19158.
[9] *Proc. Nat. Acad. Sci. USA* **2013**, *110*, 15171.
[10] *ACS Nano* **2017**, *11*, 6155.
[11] *Nano Lett.* **2017**, *submitted*.