Helen and John C. Hartmann
Department of Electrical & Computer Engineering
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Device Nanostructuring for Efficient Polymer and Hybrid Solar Cells

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ABSTRACT: Third generation photovoltaic (PV) technology, which includes emerging solar cells systems based on, for example, organic semiconductors, quantum dots, and, most recently, hybrid perovskites, has garnered extensive research interests. The steady progress of the field achieved PV power conversion efficiencies now over 10 percent across the different third generation cell systems and even higher than 20 percent for the hybrid perovskites. Despite these promising potentials, many hurdles still remain to be addressed for the practical application of these solar cells, and the foremost challenge is further increasing the device efficiencies close to the levels that respective material systems theoretically allow. One of the keys to the necessary breakthrough is the ability to manipulate and improve the basic light-matter interaction and charge transport processes within the materials, in conjunction with the improved understanding on the overarching, fundamental structure-property relation, which naturally occur in the nanometer scale. The advent of various nanostructuring strategies thus plays significant roles in enhancing the PV performance of these third generation PVs.

In this talk, I will discuss the exemplary case of organic polymer solar cells. The overview of fundamental material aspects and related device nanostructuring approaches being attempted in the field will be provided first, and some of the major progresses we have made at Brookhaven will be showcased. Toward the end of the talk, I will also briefly explain an extension of one of the nanostructuring approaches to ultrathin Si solar cells, where the bi-functional nanocrystal sensitization can increase the device performance via excitonic energy transfer and improved light coupling.

BIOSKETCH: Dr. Nam is an Associate Scientist at the Center for Functional Nanomaterials (CFN) of Brookhaven National Laboratory. He is also an Adjunct Professor of Materials Science and Engineering at Stony Brook University. Native of South Korea, he received his Ph.D. in Materials Science and Engineering at the University of Pennsylvania in 2007 with Jack Fischer. Before, he received his M.S. degree from KAIST and did his undergraduate study at Korea University. He has been a permanent scientist at Brookhaven since 2010. Prior to that, he was a prestigious, Goldhaber Distinguished Fellow of Brookhaven National Lab, working with Chuck Black. His research scope covers semiconductor nanostructures, device physics, and nanofabrication. Current research is focused on developing nanostructured semiconductor architectures and understanding their electronic and optoelectronic properties for energy harvesting and electronic device applications. Particular interests include organic and hybrid PVs, nanostructured metal oxide gas sensors, and unconventional nanofabrication based on atomic layer deposition.