Sustainable Manufacturing of Solution-Processed Devices on Flexible Substrates using Nanohybrid Materials

Summary

Global production of technology for consumer, commercial and energy use strains the world stock of certain scarce or exotic materials, while the prevalence of semiconductor fab-style manufacturing is a serious sustainability concern despite ongoing improvements. Can new materials-based approaches make a step-change difference in this scenario? M3 (Methods for Materials-efficient Manufacturing) is a 3-year project to tackle issues related to fabricating stable, functional devices and materials for roll-to-roll (R2R) manufacturing processes that are highly efficient with respect to materials, energy and cost. In contrast to conventional batch vacuum and deposition processes, M3 concentrates on solution-based processing on flexible substrates, aiming for lower manufacturing costs, reduced waste, lower energy inputs, reduced greenhouse gas emissions, and efficiencies in the use of rare/scarce materials. In science, we will develop functional device layers based on nanoparticle/polymer hybrid materials that are solution-processible, leading to such outcomes as superior high dielectric constant layers that improve the performance of transistors on flexible substrates, and using nanoparticles to tune the dielectric constant and refractive index of device layers containing rare earth phosphor emitters, thus imparting a 10X efficiency increase and using less rare earths. Other potential applications include optically-transparent water and oxygen barriers for extending lifetimes of solar and lighting devices and transparent conductive layers. In manufacturing, our team will apply solution-based fabrication using R2R process tools. In societal and broader impacts, our team will study the hybrid materials' chemical life cycles and explore societal perceptions, benefiting countless other efforts. The team brings synergistic world-class expertise in synthesis of functionalized nanoparticles and their assembly into nanostructured polymer/NP hybrid materials, as well as design and characterization of conductive, optically-active and photoemissive device layers.