ENGINEERING VERTICAL CRYSTAL ARRTAYS FOR EFFICIENT SOLAR ENERGY HARVESTING

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Solution-processable organic semiconductors promise to drive down the cost of optoelectronic devices by affording the large-scale, high-throughput manufacturing of photo- and electrically-active layers. Achieving optimal morphologies during rapid deposition from solution, however, has proven exceedingly difficult and has thus far limited the performance of these materials. A novel method is presented to control the earliest stages of nucleation and crystallization during solution-phase deposition of small-molecule organic semiconductors. Nanoporous scaffolds were introduced to the surface of device platforms that confine organic semiconductor nucleation at the air-solution-surface interface during a continuous dip coating process. These nuclei were found to preferentially orient with their fast growth direction aligned parallel to the long axis of the pores. Subsequent crystallization proceeded beyond the scaffold to form arrays of high-density, vertical crystals with large exposed surface area. X-ray diffraction analysis revealed that the vertical crystals oriented with the π-stack direction perpendicular to the substrate surface, the optimal orientation for light absorption and charge transport in organic solar cells and other devices with a sandwich electrode configuration. The height, diameter, and spacing of these crystals were tunable by varying the scaffold geometry and deposition conditions.[1] Critically, this generalizable method is compatible with continuous processing methods that will enable the large-scale manufacturing of such materials.[2]

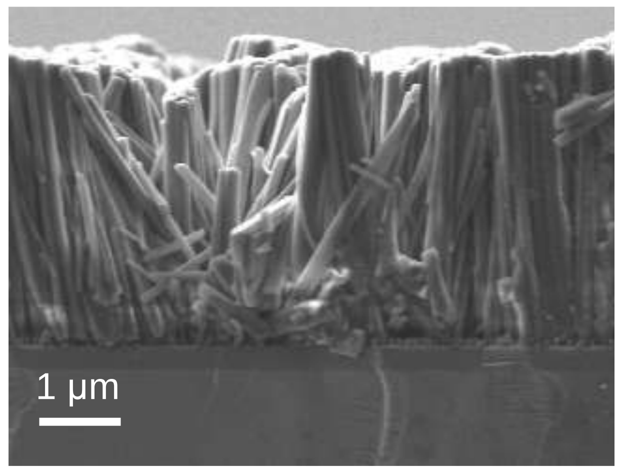

Figure 1 - Cross-sectional scanning electron micrograph of a vertical organic semiconductor crystal array deposited from solution onto a nanoporous scaffold.

References

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