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**Morphology-property insights into high-performance organic photovoltaics**[1]

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Organic solar cells have attracted increasing attention as potential low-cost alternatives to traditional inorganic photovoltaic (PV) technologies. Additional advantages of OPVs include the use of earth-abundant materials, mechanical flexibility, light weight, rapid energy payback time, and the option for tunable coloring for aesthetic architectural installation. Key to their low-cost is solution-based high-throughput processing. Power conversion efficiency (PCE) of organic photovoltaics (OPVs) has steadily improved, with PTB series polymers exhibiting some of the highest PCEs. Using a suite of advanced characterization techniques, it is possible to decipher the morphology of OPV active layers across length scales from the molecular to the mesoscopic. Correlating these structural features with optoelectronic function leads to morphology-performance relationship insights, which in turn can be utilized as the foundation for a rational design of improved performance in OPV devices. Initial results from this methodology are encouraging, suggesting a viable alternative to the traditional Edisonian approach to device performance improvement.

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