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「Developing Boron Subphthalocyanine Derivatives as Nonfullerene Acceptors for Vacuum-Deposited Organic Photodetectors」



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Boron subphthalocyanine (SubPc) is a small-molecule organic semiconductor with the potential to function as active and charge transporting layer in organic optoelectronic devices. In this work, we synthesized three β -substituted SubPcs, i.e., 6Cl-SubPc, 6O-SubPc, 6S-SucPc, and their photophysical properties, electrochemical properties and molecular geometry were investigated. Vacuum-processed small-molecule-based OPD devices are presented by utilizing a blend of SubPc and β -substituted SubPcs as the active layer. Four different active layer thicknesses are further investigated to understand the intrinsic phenomena, unveiling the suppression of dark current density while maintaining photoexcitation and charge separation efficiency. Experimental results reveal that, at an applied bias of -3 V, the 50-nm-thick active layer achieves a remarkably low dark current density of 1.002 nA cm^{-2} alongside a high external quantum efficiency (EQE) of 52.932% and a responsivity of 0.226 A W^{-1} . These impressive performance metrics lead to a specific detectivity of $1.263 \times 10^{13} \text{ Jones}$. Furthermore, the findings offer new insights into intrinsic phenomena within the bulk heterojunction (BHJ), such as thermally generated current and exciton quenching. This integration is potentially well-heeled to revolutionize display technology by combining high sensitivity photodetection, offering new possibilities for novel display panels with sensing applications.