

# Effective Cathode Interfacial Layer for Low-light/Indoor Non-fullerene Organic Photovoltaic Systems

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## Abstract

Non-fullerene Organic Photovoltaic (OPV) systems have emerged as promising candidates for renewable energy due to their efficiency and versatility. However, their performance under low-light or indoor conditions remains a challenge. This article delves into the significance of cathode interfacial layers in improving the efficacy of non-fullerene OPV systems in low-light and indoor environments. It explores the role of these layers in enhancing charge extraction, minimizing losses, and optimizing the device's overall performance. Various strategies and materials utilized in creating effective cathode interfacial layers are discussed, highlighting their impact on the efficiency and stability of OPV systems. The insights provided here aim to pave the way for the development of more efficient, stable, and adaptable organic photovoltaic technologies.

**Keywords:** Organic Photovoltaics (OPVs) • Charge extraction • Interface morphology

## Introduction

The quest for sustainable and renewable energy sources has led to significant advancements in photovoltaic technologies. Among these, organic photovoltaics (OPVs) have garnered attention for their lightweight, flexible nature and potential for low-cost manufacturing. Non-fullerene acceptors have revolutionized OPV systems, enhancing their power conversion efficiencies (PCEs) and stability. However, challenges persist, especially in harnessing energy under low-light or indoor conditions, where conventional silicon-based solar cells excel. This article focuses on addressing the limitations of non-fullerene OPV systems in low-light environments by emphasizing the pivotal role of cathode interfacial layers. These layers play a crucial role in charge extraction, interface engineering, and mitigating losses, thus influencing the overall performance of the device [1].

## Literature Review

Cathode interfacial layers serve as a bridge between the active layer of the OPV device and the cathode, facilitating efficient charge transport and reducing losses associated with recombination at the interface. In low-light conditions, where photon absorption is limited, the effective extraction of charges becomes paramount for maintaining device performance [2]. Various materials and strategies have been employed to optimize cathode interfacial layers. Electron-selective interlayers, such as metal oxides (e.g., ZnO, TiO<sub>x</sub>), polymers, or organic/inorganic hybrids, have shown promise in enhancing charge extraction and improving device stability. The tunability of these materials enables efficient energy level alignment and reduced interfacial resistance, crucial for achieving higher PCEs.

This section explores different approaches to improve the functionality of cathode interfacial layers in non-fullerene OPV systems. Chemical modifications, interface morphology control, and interface doping techniques are discussed in detail, elucidating their impact on charge extraction, carrier

mobility, and overall device performance [3]. Surface engineering through chemical treatments or Self-Assembled Monolayers (SAMs) has emerged as a powerful strategy to tailor the interfacial properties, reducing interfacial energy barriers and enhancing charge transport. Morphological control, achieved through techniques like solvent annealing or additives, influences the interfacial structure and can significantly impact the device's performance in low-light conditions. Furthermore, interface doping techniques, such as interfacial modification with metal nanoparticles or small molecules, offer opportunities to modulate energy levels, improve charge collection efficiency, and reduce charge recombination [4].

## Discussion

The selection of appropriate materials for cathode interfacial layers significantly influences the device's efficiency and stability. This section explores recent advancements in materials design, including novel polymers, metal oxides, and organic/inorganic hybrids, focusing on their suitability for enhancing low-light/indoor performance in non-fullerene OPVs [5].

Moreover, characterization techniques like X-Ray Photoelectron Spectroscopy (XPS), Atomic Force Microscopy (AFM), and impedance spectroscopy are instrumental in understanding the interfacial properties and charge transport mechanisms, aiding in the development and optimization of cathode interfacial layers [6]. Despite significant progress, challenges persist in optimizing cathode interfacial layers for low-light/indoor non-fullerene OPV systems. Interface stability, compatibility with different active layer materials, and scalability of fabrication processes remain focal points for further research. Looking ahead, advancements in novel materials synthesis, interface engineering strategies, and comprehensive understanding of charge transport mechanisms will continue to drive the development of efficient and stable cathode interfacial layers. Collaborative efforts among researchers, material scientists, and device engineers will be crucial in overcoming existing challenges and unlocking the full potential of non-fullerene OPVs.

## Conclusion

Effective cathode interfacial layers play a pivotal role in enhancing the performance of non-fullerene organic photovoltaic systems, especially in low-light or indoor conditions. Strategies focusing on material advancements, interface engineering, and characterization techniques have shown promise in improving charge extraction, reducing losses, and enhancing device stability. Continued research efforts and interdisciplinary collaborations are essential to address current challenges and propel the development of highly efficient and adaptable non-fullerene OPV technologies for a sustainable future. This comprehensive review elucidates the significance of cathode interfacial

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layers in non-fullerene OPVs under low-light conditions, offering insights and directions for future research and development in the field of organic photovoltaics.

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## Conflict of Interest

None.

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## References

1. Jahandar, Muhammad, Soyeon Ki and Dong Chan Lim. "Indoor organic photovoltaics for self sustaining lot devices: Progress, challenges and practicalization." *Chem Sus Chem* 14 (2021): 3449-3474.
2. Liu, Qishi, Yufan Jiang, Ke Jin and Jianqiang Qin, et al. "18% Efficiency organic solar cells." *Sci Bulletin* 65 (2020): 272-275.
3. Jiang, Pei, Lu Hu, Lulu Sun and Hongwei Han et al. "On the interface reactions and stability of nonfullerene organic solar cells." *Chem Sci* 13 (2022): 4714-4739.
4. Chen, Qi, Cheng Wang, Yaowen Li and Liwei Chen. "Interfacial dipole in organic and perovskite solar cells." *J America Chem Soc* 142 (2020): 18281-18292.
5. Park, Song Yi, Yuxiang Li, Jaewon Kim and Tack Ho Lee, et al. "Alkoxybenzothiadiazole-based fullerene and nonfullerene polymer solar cells with high shunt resistance for indoor photovoltaic applications." *ACS Appl Mater Interface* 10 (2018): 3885-3894.
6. Singh, Ranbir, Christos L. Chochos, Vasilis G. Gregoriou and Alkmini D. Nega, et al. "Highly efficient indoor organic solar cells by voltage loss minimization through fine-tuning of polymer structures." *ACS Appl Mater Interface* 11 (2019): 36905-36916.

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