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Tuning photovoltaic donor polymer molecular weight characteristics

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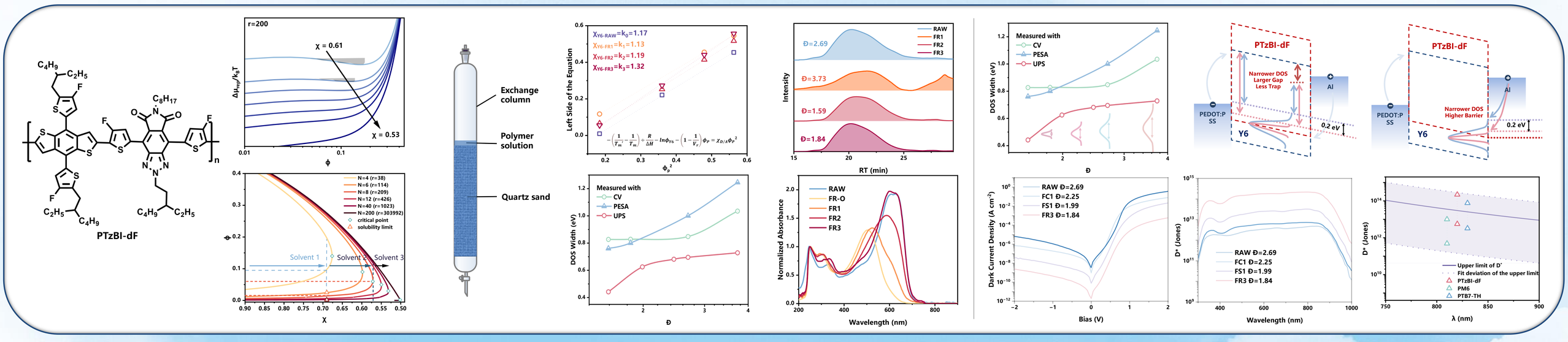
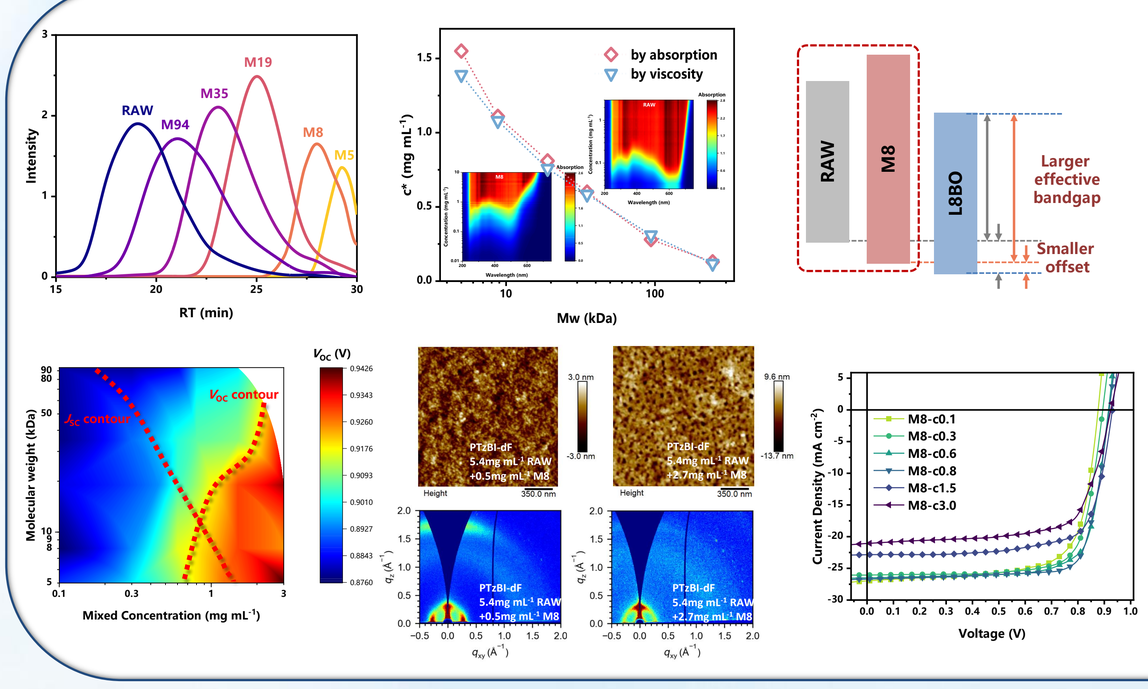
Introduction: The performances of the photovoltaic polymers are closely related to the molecular weight and polydispersity (Đ) of the semiconducting polymers. Based on Flory-Huggins solution theory, we herein demonstrated the fractionation of batches of semiconducting polymers with comparable molecular weights while diverse polydispersity through a solution fractionation strategy, as well as mixing-molecular-weight strategy, which can macroscopically and statistically tailor energy level alignment, energy bandwidth, and chain elastic entropy. These results provide a simple and rational guide for large-scale OPV production to overcome batch-to-batch change and illustrate new possibilities for further performance improvement of OPV.

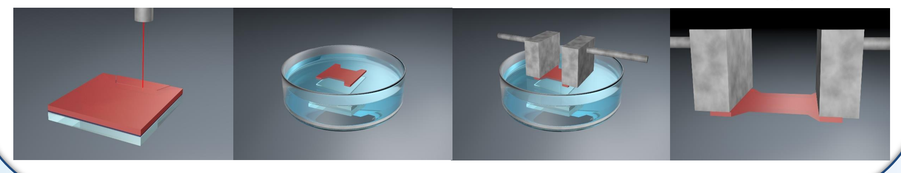
Narrowed MW distribution



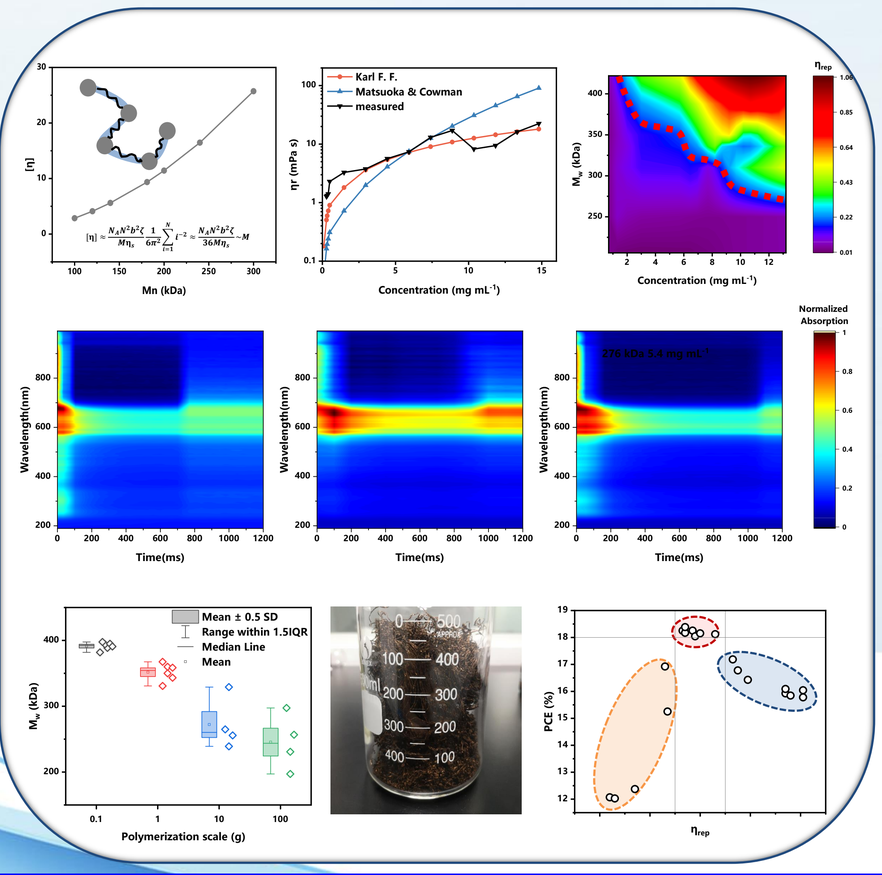
Mix-MW strategy guided with c^*_{agg}



Stretchability



Scale-up



Conclusion

In summary, the photovoltaic polymer is regulated through the dimensions including length, length distribution, flexibility, and network of the polymer chains, realizing the performance improvement of organic photovoltaic devices from different dimensions. It's found that a narrower molecular weight distribution reduces both the dark current density inside the bulk junction and at the cathode/active layer interface by increasing the potential barrier. While adhering to an analogous protocol, wider optimal mixing ratios for the MW-mixed donor polymers were expeditiously determined, culminating in an elevation of the PCE beyond 19%. These approaches, predicated on the thermodynamic principles of polymer solutions, furnish rational and straightforward directives for the fabrication of high-performance organic photovoltaics based on the donor polymers with the same PTzBI-dF chemical structures but varying energy level or molecular weight characteristics, thereby harboring substantial potential for organic photovoltaics to surmount the challenges posed by polymer batch-to-batch variability and to progress towards expansive practical applications.

Acknowledgement

Financially supported by National Natural Science Foundation of China (Nos. 51933003 and U21A6002), Guangdong Basic and Applied Basic Research Foundation (2023B1515040026), and Guangdong Major Project of Basic and Applied Basic Research (No. 2019B030302007).