école normale supérieure paris–saclay

Laboratoire PPSM – UMR CNRS 8531

Photochimie et Photophysique

Supramoléculaireset Macromoléculaires

Séminaire PPSM

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Amphithéâtre Fonteneau, Bâtiment d'Alembert

ENS Paris-Saclay

Professeur Henry YAN

Department of Chemistry Hong Kong University of Science and Technology, Chine

Invité par : Gilles Clavier (LabEx CHARMMMAT)

«Achieving non-fullerene organic solar cells with over 16% efficiency»

Organic solar cells (OSCs) are flexible, semi-transparent and environmentally friendly devices which can be installed in areas where silicon panels are not suitable (such as glass windows on buildings). Conventional OSCs are based on fullerene acceptors as a key component. However, fullerene-based OSCs can only achieve modest efficiency of 12% at best, due to their large voltage loss (above 0.8V), and poor device stability.

Recently, there has been a major revolution in the OSC field, as researchers developed many high-performance non-fullerene acceptors that can overcome the limitation of traditional fullerene acceptors and open a new era for the OSC field. One of the unique features of non-emerging non-fullerene OSCs is the surprisingly small voltage losses of the devices (~ 0.5V). Since 2016, our team at HKUST has developed a range of non-fullerene systems that can simultaneously generate high photocurrent (near 100% yield) with small voltage losses (first published in Nature Energy). Moreover, we have recently achieved record-breaking OSCs based on a state-of-the-art non-fullerene acceptor, achieving an unprecedented efficiency of 16.7% in single-junction OSC device. Our work clearly indicate that OSCs have the potential to reach the high efficiency of inorganic solar cells.

Our results show that the key factor is the long charge transfer life-time that allows for efficient charge separation despite of a small energy offset. In the other aspect, we study structure-property relationship of high-performance donor and non-fullerene acceptor materials and reveal the key structure features that enable highly efficient non-fullerene organic solar cell devices with over 16% efficiency. With these understandings of mechanism and structure-property relationship, it is feasible to further increase the efficiency of organic solar cells to the range of 18 to 20% in near future.

ÉCOLE NORMALE SUPÉRIEURE PARIS-SACLAY 61 avenue du Président Wilson 94 235 Cachan Cedex
www.ens-paris-saclay.fr Tél : +33 (0)1 47 40 20 00

PPSM
ENS Paris-Saclay – 61 avenue du Président Wilson
94235 Cachan Cedex – France
Tél : *+33 1 47 40 53 38 –* ***Fax :*** *+33 1 47 40 24 54*
e-mail : *secretariat@ppsm.ens-cachan.fr*
site web : *http://www.ppsm.ens-cachan.fr*

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