Progress in fused-ring electron acceptors

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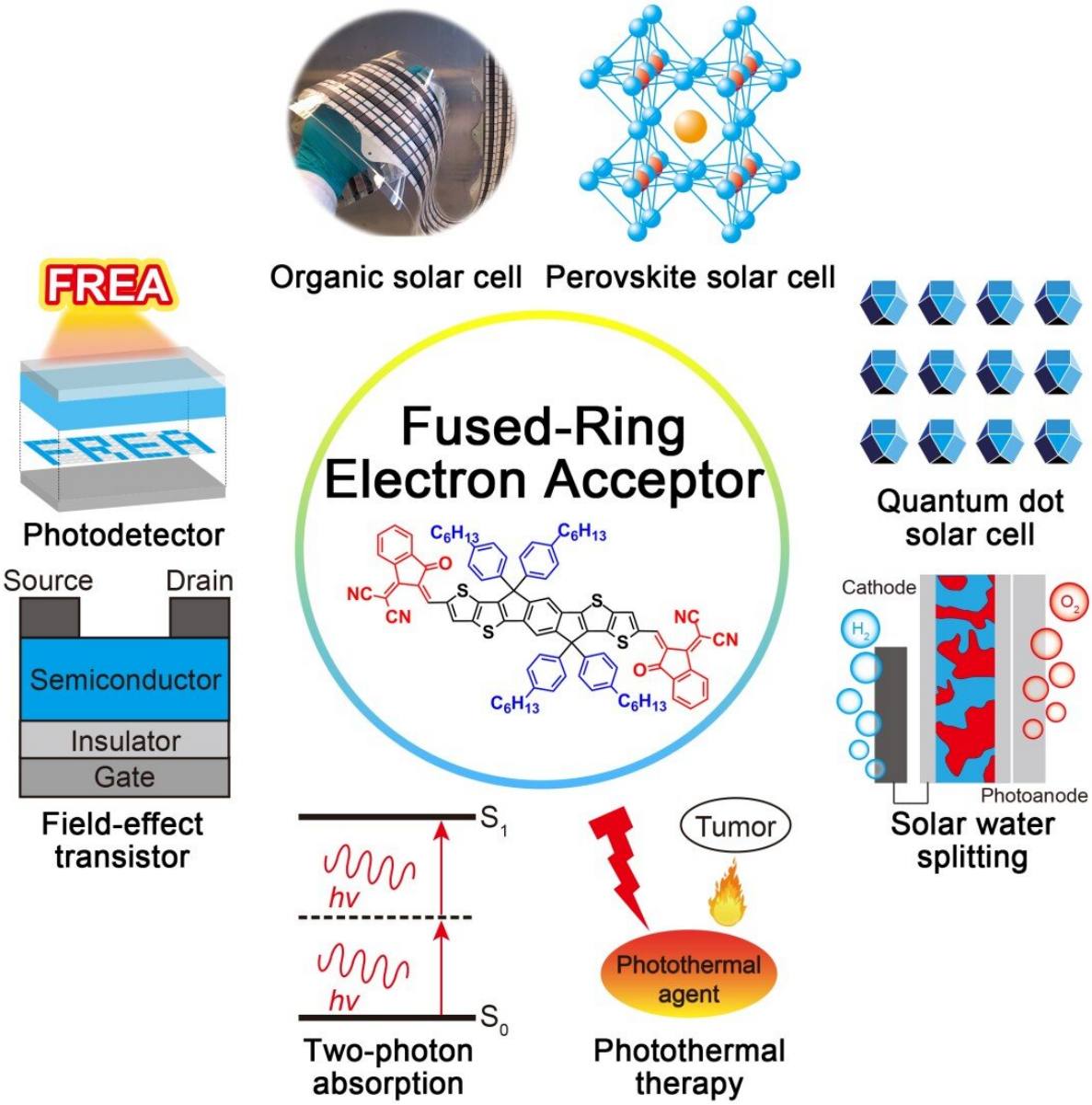

The structure of ITIC and applications of FREAs. Credit: College of

From 1995-2015, fullerene derivatives had been the dominating electron acceptors in organic solar cells (OSCs) owing to their performance superiority to other acceptors. However, the drawbacks of fullerenes, such as weak visible absorption, limited tunability of electronic properties and morphological instability, restrict further development of OSCs toward higher efficiencies and practical applications. Therefore, the development of new acceptors beyond fullerenes is urgent in the field of OSCs.

Professor Zhan Xiaowei from the College of Engineering at Peking University is one of the pioneers engaging in development of nonfullerene acceptors in the world. In 2007, Zhan's group pioneered perylene diimide-based polymer acceptors. In 2015, they invented the star molecule ITIC and proposed the concept of fused-ring electron acceptor (FREA). Then, they developed a variety of molecular design strategies, modulated the molecular properties through engineering on fused-ring cores, π-bridges, end groups and side chains, and revealed the structure-property relationships. They found new device physics and photophysics in FREAs, different from fullerenes. They fabricated high-performance OSCs and FREA-perovskite hybrid cells. The chemical features, physical features and device features of FREAs are different from traditional fullerenes. Thanks to the invention of FREA, OSCs have achieved unprecedented breakthroughs with efficiencies surpassing 18% in 5 years. FREA brings a revolution for the OSC field and heralds the arrival of nonfullerene era.

FREAs have also been used in other fields, such as perovskite solar cells, quantum dot solar cells, solar water splitting, photodetectors, field-effect transistors, two-photon absorption, photothermal therapy, etc. FREAs

have attracted broad attention around the world: over 150 groups are using FERAs in OSCs, over 50 groups are using FREAs in other fields, and over 10 companies are selling FREAs. Nowadays, FREA is a new and hot field led by Chinese scientists and followed worldwide.

More information: Jiayu Wang et al, Fused-Ring Electron Acceptors for Photovoltaics and Beyond, *Accounts of Chemical Research* (2020). DOI: 10.1021/acs.accounts.0c00575

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