Designing semiconductor structures for solar fuel synthesis

Jie CHEN

Xi'an Jiaotong University, Xian, CHINA
jie.chen@xjtu.edu.cn

Solar fuel synthesis refers to the process of using renewable energy sources such as solar energy, along with carbon dioxide and water, to synthesize hydrocarbon fuels. This is a type of energy storage technology that converts intermittent and dispersed renewable energy into storable forms. Currently, solar fuel synthesis technologies are divided into three main routes: photocatalysis, photoelectrocatalysis, and photovoltaic-electrocatalysis. From a fundamental perspective, the first step in each of these routes is the absorption of light energy and its conversion into electrical energy within a semiconductor, forming electron-hole pairs. This step determines the number of charge carriers available for subsequent catalytic reactions, thereby setting the upper limit of the solar fuel synthesis efficiency for each route. Therefore, high-quality semiconductor materials, characterized by a wide light absorption range, high charge mobility, and long migration distances, are essential for achieving efficient solar fuel synthesis. For semiconductors, their "structure" is crucial to their properties and performance. However, the current field encompasses a broad and rich understanding of structure, including but not limited to molecular structure, band structure, micro/nano morphology, crystal structure, and electronic structure. So, which aspect of structure is the key factor influencing the properties and performance of semiconductors? To answer this question, the presenter conducted related research from the perspective of the molecular structure of organic semiconductors and the micro/nano morphology of inorganic semiconductors, focusing on how to enhance the light absorption and charge transport capabilities of semiconductor materials, thereby improving the efficiency of solar fuel synthesis [1-6].

References

[1] J. Chen, C. Dong, H. Idriss, O.F. Mohammed, O.M. Bakr, *Adv. Energy Mater*. **10** 1902433 (2020)
[2] J. Chen, Z. Luo, Y. Fu, X. Wang, K.J. Czech, S. Shen, L. Guo, J.C. Wright, A. Pan, S. Jin, *ACS Energy Lett*. **4**(5) 1045 (2019)
[3] Q. Wang, L. Ren, J. Zhang, X. Chen, C. Chen, F. Zhang, S. Wang, J. Chen, J. Wei, *Adv. Energy Mater*. **13** 2301543 (2023)
[4] D. Zhao, Y. Wang, C.L. Dong, Y.C. Huang, J. Chen, F. Xue, S. Shen, L. Guo, *Nat. Energy* **6** 388 (2021)
[5] J. Chen, D.J. Morrow, Y. Fu, W. Zheng, Y. Zhao, L. Dang, M.J. Stolt, D.D. Kohler, X. Wang, K.J. Czech, M.P. Hautzinger, S. Shen, L. Guo, A. Pan, J.C. Wright, S. Jin, *J. Am. Chem. Soc*. **139** 13525 (2017)
[6] J. Chen, C.L. Dong, D. Zhao, Y.C. Huang, X. Wang, L. Samad, L. Dang, M. Shearer, S. Shen, L. Guo, *Adv. Mater.* **29** 1606198 (2017)

Designing semiconductor structures for solar fuel synthesis

Jie CHEN

Xi'an Jiaotong University, Xian, CHINA
jie.chen@xjtu.edu.cn

BIO

Prof. Dr. Jie Chen received his Ph.D. in 2017 from Xi'an Jiaotong University (XJTU) followed by a post-doctoral fellow at the King Abdullah University of Science and Technology. In 2021, he became associate Professor at XJTU and was promoted to full Professor in 2022. He focuses on the application-oriented basic research of solar photochemical conversion materials and devices. To date, he has published over 70 papers in international journals and co-authored a chapter in a book. Among these, he has published more than 30 papers as the first or corresponding author in high-impact SCI journals such as Chem. Rev., J. Am. Chem. Soc., Adv. Mater., Nano Lett., ACS Energy Lett. (3), Adv. Energy Mater. (2), and Sci. Bull. His research papers have been cited over 7,500 times, and he has an H-index of 39. He has received several accolades, including the National Excellent Young Scientists Fund (Overseas), Shaanxi Qin Chuang Yuan High-level Innovation and Entrepreneurship Talent, and awards for Outstanding Doctoral Dissertation from both Shaanxi Province and Xi'an Jiaotong University. From 2020 to 2023, he was consecutively recognized as one of the top 2% of scientists globally by Stanford University. Currently, he serves as a young editorial board member for eScience and Frontiers in Energy.