Journey towards Micro- and Opto-electronic Applications of Metal–Organic Frameworks in the Semiconductor Industry

Muhammad Usman, PhD, Delft University of Technology, Delft, Netherlands

Abstract

Metal–organic frameworks (MOFs) have emerged as a promising class of materials with a wide spectrum of useful applications in gas absorption, catalysis, biomedical and sensing etc. Their unique properties arising from the self-assembly of metal ions/clusters with electron-donating organic linkers, enable ordered frameworks with tunable functionalities, uniform pore sizes, post-synthesis modification, rich coordination chemistry and fascinating topologies are prompting us to further explore their micro- and optoelectronics properties. MOFs with advantageous properties of both inorganic and organic components, promise to serve as the next generation of the electronics materials with the potential to be extremely stable, cheap, and mechanically flexible (Figure 1). I have investigated fundamental dielectric, semiconducting and optical properties of various MOFs and summarized the initial theoretical and experimental research. In this talk, I will discuss about my journey from fundamental properties towards device designing using MOF as an active component. Current study presents a significant and encouraging step towards a new research direction focused on potential applications of MOFs in the semiconductor industry.

Image

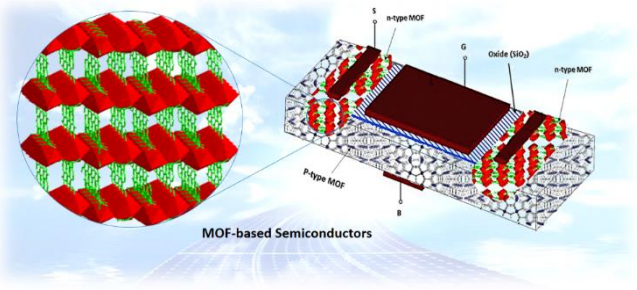


Figure 1. MOF-based semiconductor could be used as an active component in transistors technology.

Recent Publications (minimum 5)

1. M. Usman, K. P. Bera, G. Haider, S. Batjargal, M. Hayashi, G. H. Lee, S. M. Peng, Y. F. Chen, K. L. Lu (2019) Single Molecule Based Electroluminescent Device as Future White Light Source. ACS Appl. Mater. Interfaces, 11:4084–4092.
2. M. Usman, S. Mendiratta, K. L. Lu (2017) Semiconductor Metal–Organic Frameworks and their Bandgap Investigation, Adv. Mater., 29:1605071.
3. M. Usman, G. Haider, S. Mendiratta, T. T. Luo, Y. F. Chen, K. L. Lu (2016) Continuous Broadband Emission from a Metal–Organic Framework as a Human-Friendly White Light Source, J. Mater. Chem. C, 4:4728–4732.
4. M. Usman, K. L. Lu (2016) Metal–Organic Frameworks: Future of Low-k Materials, NPG Asia Mater., 8: e333.
5. M. Usman, S. Mendiratta, S. Batjargal, G. Haider, M. Hayashi, N. R. Gade, J. W. Chen, Y. F. Chen, K. L. Lu (2015) ACS Appl. Mater. Interfaces, 7:22767–22774.



Biography

After receiving his PhD from National Central University, Taiwan in 2015, Dr. Muhammad Usman worked at the Institute of Chemistry, Academia Sinica as a postdoctoral fellow. In 2019, he went to USA for his postdoctoral research at New Mexico Highlands University, Las Vegas. There, he participated in a collaborative project between New Mexico Highlands University and the Ohio State University. During past few years, he conducted research on the dielectric, semiconducting and optical properties of metal–organic frameworks and designed their fundamental device for industrial applications. He has published several articles including 3 patents, a book chapter and 9 first author journal articles with total impact factor of more than 200 and 650+ citations. He has won several awards including two silver medals from COMSATS, Pakistan and young investigator awards at the Frontiers in Photochemistry Conference, Bahamas, USA in 2020.

Email: m.usman-2@tudelft.nl

Notes/Comments: