



Carbon-based energy-efficient semiconductors for emerging technologies

Thuc-Quyen Nguyen^{1*}

Center for Polymers and Organic Solids and Department of Chemistry & Biochemistry, University of California, Santa Barbara, USA

*E-mail: quyen@chem.ucsb.edu

Organic semiconductors (OSCs) are a class of carbon-based materials comprising of alternate single and double bonds (conjugated pi-bonds). They can be synthesized to have band gaps from the UV to the near infrared regions of the electromagnetic spectrum. OSCs are attractive due to their unique properties: light weight, mechanical flexibility, low cost, low-temperature synthesis and processing, and simple fabrication methods such as roll-to-roll coating, spray coating or ink-jet printing into desired size and shape. Such materials are expected to form the basis of new emerging technologies — called the Organic Electronics. OSCs have been implement in commercial products such as displays and lightings and have potential applications in transistors, solar cells, photodetectors, thermoelectrics, ratchets, sensors, neuromorphic computing, and bioelectronics. In this talk, I will discuss the development of OSCs for applications in organic photovoltaics,¹⁻³ organic photodetectors,⁴⁻⁶ and organic electrochemical transistors.^{7,8} I will highlight how chemical structures and processing conditions can be used to tune the materials properties and therefore the device performance. The results from these studies provide design guidelines for new generation of carbon-based energy-efficient semiconductors for applications in emerging technologies.

Keywords: Organic semiconductors; organic solar cells; organic photodetectors; organic electrochemical transistors; solution-process

References

1. A. Karki, J. Vollbrecht, A. Gillett, S. Xiao, Y. Yang, Z. Peng, N. Schopp, A. Dixon, S. Yoon, M. Schrock, H. Ade, G.N. Manjunatha Reddy, R. Friend, T.-Q. Nguyen, *Energy & Environmental Science* 2020, **13**, 3679-3692.
2. A. Karki, A. J. Gillett, R. H. Friend, T.-Q. Nguyen, *Adv. Energy Mater.* 2021, **11**, 2003441.
3. Safa Shoaee, Hoang M. Luong, Jiage Song, Yingping Zou, Thuc-Quyen Nguyen, Dieter Neher, *Adv. Mater.* 2024, **36**, 2302005.
4. Z. Du, H. M. Luong, S. Sabury, A. L. Jones, P. Panoy, Z. Zhu, S. Chae, A. Yi, H. J. Kim, S. Xiao, V. V. Brus, G. N. Manjunatha Reddy, J. R. Reynolds, T.-Q. Nguyen, *Adv. Mater.* 2024, **36**, 2310478.
5. H. M. Luong, C. Kaiyasuan, A. Yi, S. Chae, B. M. Kim, P. Panoy, H. J. Kim, V. Promarak, Y. Miyata, H. Nakayama, T.-Q. Nguyen, *ACS Energy Letters* 2024, **9**, 1446-1454.
6. H. M. Luong, S. Chae, A. Yi, J. Chatsirisupachai, B. M. Kim, Y. Wan, V. Promarak, H. J. Kim, T.-Q. Nguyen, *Matter* 2024, **7**, 2473.
7. S. Chae, T. Nguyen-Dang, J. Chatsirisupachai, A. Yi, R. J. Vázquez, G. Quek, V. Promarak, H. J. Kim, G. C. Bazan, T.-Q. Nguyen, *Adv. Funct. Mater.* 2024, **34**, 2310852.
8. T. Nguyen-Dang, A. S. T. Bao, C. Kaiyasuan, K. Li, S. Chae, A. Yi, J. Syed, K. Harrison, J. Y. Kim, F. Pallini, L. Beverina, K. Graham, C. Nuckolls, T.-Q. Nguyen, *Adv. Mater.* 2024, **36**, 2312254.



Biography

Thuc-Quyen Nguyen is the Director of the Center for Polymers and Organic Solids and professor in the Department of Chemistry & Biochemistry at the University of California, Santa Barbara. Nguyen received her B.S. (1997), M.S. (1998), and Ph.D. (2001) degrees in Physical Chemistry from the University of California, Los Angeles under the guidance of Professor Benjamin Schwartz. From 2001-2004, she was a postdoc in the Department of Chemistry and the Nanocenter at Columbia University working with Nobel Laureate Louis Brus and Professor Colin Nuckolls on molecular self-assembly, nanoscale characterization and devices. She also spent time at IBM Research Center at T. J. Watson (Yorktown Heights, NY) working with Richard Martel and Phaedon Avouris on molecular electronics. She joined the faculty of the Chemistry and Biochemistry Department at UCSB in 2004.



Her research interests are organic semiconductors, bioelectronics, device physics of organic solar cells, ratchets, transistors, and photodetectors, and sustainability.

She is co-authored over 315 publications and 3 book chapters that received over 40,000 citations (H-index: 103) and gave over 330 plenary/keynote/invited talks at national and international conferences, universities, and companies. Recognition for her research includes 2005 Office of Naval Research Young Investigator Award, 2006 National Science Foundation CAREER Award, 2008 Camille Dreyfus Teacher Scholar Award, 2009 Alfred Sloan Research Fellows, 2010 National Science Foundation American Competitiveness and Innovation Fellows, 2015 Alexander von Humboldt Senior Research Award, 2016 Fellow of the Royal Society of Chemistry, 2019 Hall of Fame - Advanced Materials, 2019 Beaufort Visiting Scholar, St John's College (Cambridge University), 2015-2019 World's Most Influential Scientific Minds; Top 1% Highly Cited Researchers in Materials Science by Thomson Reuters and Clarivate Analytics, 2019 Fellow of the American Association for the Advancement of Science (AAAS), 2023 Wilhelm Exner Medal from Austria, 2023 Fellow of the US National Academy of Inventors, 2023 de Gennes Prize in Materials Chemistry from the Royal Society of Chemistry, 2023 Elected Member of the US National Academy of Engineering, French National Centre for Scientific Research (CNRS) Chimie Ambassador in Chemical Sciences, 2024 Fellow of the European Academy of Sciences, and 2025 ACS Henry H. Storch Award in Energy Chemistry.

In 2020, Nguyen helped establish the VinFuture Prize Foundation in Vietnam to honor exceptional scientific works that create meaningful changes in everyday life of millions of people (<https://vinfutureprize.org/>). Currently, she chairs the VinFuture Pre-screening Committee.

She was a scientific editor for Materials Horizons from 2013-2022. She serves in advisory boards for 17 journals including Advanced Materials, Advanced Functional Materials, ACS Energy Letters, Materials Horizons, Energy & Environmental Science Solar, Polymer Chemistry, Material Chemistry Frontiers & Journal of Materials Chemistry C, Cell Reports Physical Science, Chemical Physics Reviews, Mater, etc.