

CiQUS Lectures



Molecular Processes and Dynamics at Colloidal Surfaces and Biological Membranes

Hai-Lung Dai

Single Molecule Switching and Sensing

Eric Borguet



Department of Chemistry - Temple university, Philadelphia, USA

Thursday, May 19, 2022
6 p.m. Only CiQUS Seminar Room

FONDO EUROPEO DE DESARROLLO REGIONAL
PO FEDER Galicia 2014-2020 – Unha maneira de facer Europa

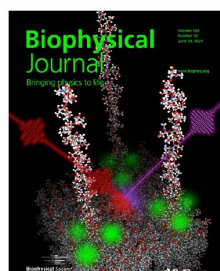
Link to group website:

Hai-Lung Dai: <https://thedaigroup.weebly.com/>

Eric Borguet: <https://sites.temple.edu/borguet/>

Abstract Hai-Lung Dai:

Properties of colloids containing micro- and nanoparticles are much influenced by the structure of and interactions at the interfaces buried in the condensed medium. It is important that chemists can characterize the buried interface – define its structure and probe the dynamics and kinetics occurring there.



Nonlinear light scattering from colloidal particles has been developed into a powerful and versatile technique for characterizing interfaces, including surfaces of colloidal particles. Today, second harmonic light scattering (SHS) from the particle surface can be quantitatively described by theoretical models and used for measuring adsorption kinetics, molecular structure, and reaction rates at the surfaces of a variety of micron to nanometer size particles. Further the dynamics on ultrafast time scale can be probed by pump-probe spectroscopy.

In this presentation, we will show that the combination of SHS, in both spectroscopy and microscopy formats, and ultrafast spectroscopy can be used for

- 1) Understanding electron dynamics in photosensitized nanomaterials for photovoltaic and photocatalytic functions;
- 2) Measuring chemical reactions at the surfaces of colloidal nanoparticles and air-borne aerosols; and
- 3) Observing molecular transport in real time at individual membranes in the multimembrane wall of living bacteria and differentiating the Gram bacteria.

Biosketch Hai-Lung Dai:

Hai-Lung Dai, currently Laura Carnell Professor of Science and Vice President for International Affairs at Temple University, was born in 1954 in Taiwan and became a naturalized citizen of the US in 1993.

A graduate of National Taiwan University (1974), he holds a PhD from UC Berkeley (1981), and was a postdoctoral fellow at MIT (1981-84). In 1984 he joined as assistant professor of chemistry at the University of Pennsylvania where he received tenure in 1989 and was promoted to full professor in 1992. From 1996-2002 he served as Chair of the Chemistry Department for two terms and later funded the Penn Science Teacher Institute. In 2002 he was appointed the Hirschmann-Makineni Professor of Chemistry. Near the end of his chairmanship, the Penn Chemistry Department ranked #6 in the nation in research funding. The PSTI programs he created were cited by the National Academies as a model for training science teachers and in 2006 he was invited to testify in the US Senate on science teacher training.

In 2007, Dai moved to Temple University as Dean of the College of Science and Technology. His deanship was characterized by a major influx of world renowned faculty, tripling the research funding, a new research and education building, and transformative changes in education and services for students. New educational initiatives included research opportunities for undergraduates, and the TUTEACH program for educating high school math and science teachers. Since 2010, Dai also assumed the responsibility of overseeing International Affairs. Under his leadership, Temple has created new collaborative degree programs with partner universities; established several liaison offices abroad; vastly expanded Temple's partnerships all over the world; and more than doubled the number of international students on Temple campus. His effort of globalizing Temple's education has been recognized by the Association of Public and Land Grant Universities' 2013 Malone Award in International Leadership, and a Knight Order of the Star Medal in 2017 from the government of Italy.

From 2012 to 2016, Dai was Provost and Executive Vice President. As the chief academic officer, he led the effort to design and implement a new scholarship and financial aid plan aimed at improving student success and reducing student debt, started a new faculty recruiting campaign with substantial investment in research support, and launched a series of effort aimed at improving the education quality and reputation. Temple's student application increased by 80% during his tenure and enrollment increased in both number and quality. Temple's USNWR ranking saw a 20-place jump. In 2016 Temple became a Carnegie R1 research university and ranked 18th in the world in the webometrics Google citation ranking. Starting 2017, Dai continues his service as Vice President for International Affairs.

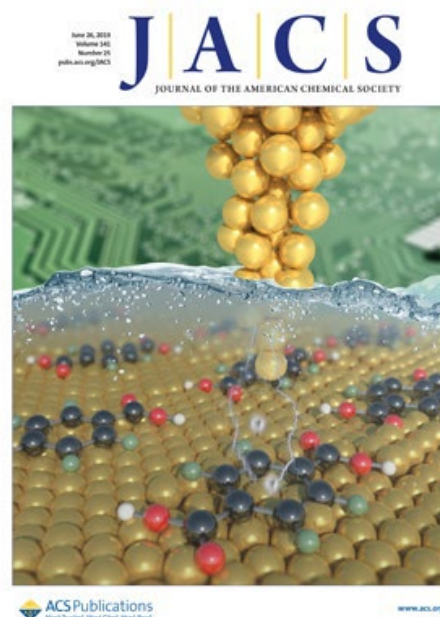
Dai is an active, funded researcher in physical chemistry and colloidal and surface sciences. He has published 200 articles and delivered more than 350 invited lectures. His many honors include Guggenheim Fellowship, Humboldt Fellowship from Germany, the Coblentz Prize in Spectroscopy, the Ellis Lippincott Award from the Optical Society of America, the Langmuir Lecturer Award in Colloid and Surface Chemistry of the American Chemical Society, and named lectureships including the Morino Lectureship of Japan. He is a Fellow of both the American Chemical Society and American Physical Society and served as Chair of the APS Chemical Physics Division. In 2017, he was honored by his alma mater National Taiwan University as a distinguished alumnus and in 2019 the Journal of Physical Chemistry published a Festschrift honoring his contribution and leadership in chemistry.

In addition to a gubernatorial appointment in the Pennsylvania State Board on Drug, Device and Cosmetic in 2002-2006, Dai has served to advise government agencies, professional societies, civic organizations, universities and research institutions around the world. He has been a choral conductor since college and conducted many orchestral concerts in the Academy of Music, Kimmel Center, and Temple Performing Center in Philadelphia, and the Beijing Concert Hall and the Shanghai City Hall of Science.

Abstract Eric Borguet:

Charge transport through and between molecules is central to important processes in nature. Studying the conductivity of single molecules can contribute to a better understanding of charge transport, and also help develop building blocks of molecular electronics, light harvesting devices, etc. We use the Scanning Tunneling Microscope break-junction (STM-BJ) method to repeatedly form circuits where one or a few molecules are trapped between two electrodes, at least one of which has nanoscale dimensions. The statistical analysis of thousands of measurements yields the conductance of single molecules.

One particular interest is the role of the molecule-electrode contact in charge transport. In the simplest analysis this contact can present a substantial barrier to charge injection, which can have important consequences in devices such as dye sensitized semiconductor nanoparticle solar cells. We have demonstrated that carbodithioate termination of molecules can enhance conductivity by an order of magnitude. We have also shown how the sensitivity of the electrical conductivity of single molecules to external perturbations can allow for switching and sensing, as well as the use of single molecule conductance for the discovery of novel materials. Our most recent developments include controlling the orientation of the molecule in the junction using the electrode potential so that we can measure charge transport along different molecular axes, accessing elements of the single molecule conductivity tensor, with the additional perspective of single molecule electromechanical switches.



Biosketch Eric Borguet:

Dr. Eric Borguet is a Professor of Chemistry at Temple University in Philadelphia, PA. He was born in Dublin, Ireland, where he spent his formative years. He attended college in France at the Université de Paris-Sud (XI-Orsay) where he studied chemistry and physics. He traveled to Philadelphia, Pennsylvania in the USA and obtained his Ph.D. in Physical Chemistry at the University of Pennsylvania in 1993, under the mentorship of Professor Hai-Lung Dai where he investigated adsorption and intermolecular interaction on stepped metal surfaces. His post-doctoral training was completed at Columbia University in the group of Professor Kenneth Eisenthal using nonlinear optics to investigate spectroscopy and ultrafast dynamics at liquid interfaces.

Chemical and physical processes at surfaces and interfaces are the principal focus of his ongoing research program at Temple University. His research activities have resulted in over 150 peer-reviewed publications, in excess of 280 invited talks and more than 250 contributed presentations.

Eric has mentored 27 graduate students, 20 of whom earned a Ph.D. and went on to post-doctoral fellowships, as well as industrial and academic careers. He has advised over 90 undergraduate researchers, many of whom have continued to graduate studies. His group has welcomed 13 visiting graduate students, as well as 5 sabbatical visiting scholars.

Source: <https://sites.temple.edu/borguet/borguet-bio/>