Amplification of Light Energy Conversion in Dye-Sensitized Solar Cells and Quantum Dot Solar Cells by Trapping Light in Photonic Crystals.

Lara Halaoui
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Abstract
Localizing light, or orthogonalizing its flow, in nanoscale architectures can decouple the dimensions along which light harvesting and carrier transport take place, which will allow for more efficient conversion of light in thin film and nanostructured solar cells. In this work, we investigate light trapping effects that occur in photonic crystals and upon coupling photonic crystals with semiconductor films on solar energy conversion in both dye-sensitized and quantum dot sensitized solar cells. A dye-sensitized nanocrystalline (nc-) TiO_2 film coupled to a TiO_2 inverse opal with a stop band at 600 nm (600-i-TiO_2-o), for instance, featured amplification in the photon-to-current conversion efficiency within both the stop band and the dielectric band of the photonic crystal relative to nc-TiO_2. The origin of the amplification within the dielectric band was studied by comparing to nc-TiO_2 coupled with a disordered inverse TiO_2 film, coined inverse TiO_2 glass (i-TiO_2-g), fabricated to have the same monodisperse air-hole size as the inverse opal by replication of a disordered polystyrene photonic glass assembled in the presence of salt. It is concluded that photonic effects dependent on the presence of periodicity in the photonic crystal cause localization of light within the nc-TiO_2 coupled to 600-i-TiO_2-o not only within the stop band but also within the dielectric band. Solar energy conversion was also studied in titania inverse opals sensitized with CdS quantum dots (Q-CdS), or with quantum-confined CdSe or CdTe films. Significant gains in light absorbance and photocurrent generation were observed to the blue of a photonic crystal stop band over a wide frequency range. We discuss the role of order versus disorder in affecting the light trapping mechanisms.

Lara Halaoui
Lara Halaoui is a Professor of Chemistry at the American University of Beirut. She received her BS in Chemistry with distinction from AUB in 1992, and her Ph.D. from Duke University in 1997. Following a postdoctoral fellowship at the University of Texas at Austin with Allen J. Bard, she joined the faculty of the Department of Chemistry at AUB in October 1998, where she remained since. In 2002-03 she was a Fulbright scholar at Pennsylvania State University and in 2012 a visiting scholar at the Massachusetts Institute of Technology. Since 2013 she has been Associate Dean of the Faculty of Arts and Sciences at AUB. She leads a research program at AUB in electrochemistry and nanoscale materials focusing on renewable energy, and is currently researching light trapping effects in photonic and plasmonic materials for enhancing solar energy conversion, and studying electrocatalysts from earth abundant materials and their coupling to photoanodes for water oxidation.

Ambient mechanochemical reaction of differently functionalized carbon nanotubes leading to their unzipping

Ahmad Kabbani
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Abstract :
A novel ambient, one pot ,smooth mechanochemical reaction (MCR) between differently functionalized multiwalled carbon nanotubes (MWCNTs) leading to their unzipping is presented. Characterization of the graphene product thus formed is discussed using spectroscopic and electron microscopy techniques.
The quality of the unzipping graphene product obtained through MCR is compared to those obtained through oxidative/reductive and argon etching ones. The MCR reaction is discussed in terms of a hydrogen-bond mediated proton transfer mechanism. The advantage the graphene produced at the device wafer level is discussed.

Ahmad Kabbani
Ahmad Kabbani is a Professor of Chemistry at the Lebanese American University . He received his BS in Chemistry from the Lebanese University in 1972, his MSc from AUB in 1974 and his Ph.D. from University of California-Davis. He joined the Lebanese U-Faculty of Science in 1980.In 1987 he was an NIH scholar to the University of California –Davis with Professor Gerd LaMar. In 2006 he was a visiting scholar to Rice
University-Electrical and computer engineering. In 2012 he was a visiting professor to Rice U.
Research areas in the last three years

A. Synthesis of nanoparticles from biological precursors
B. Ambient mechanchemical reactions of CNTs leading to their unzipping
C. Functionalization of graphite oxide
D. Covalent Cross-linking of CNTs
E. New routes to diamond-like carbon (DLC)
F. Reverse of β −lactamase action against antibiotics using gold nanoparticle

Nanotechnology for Drug Delivery: Drug Nanoparticle Formation via Flash Nanoprecipitation

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Abstract

Our research interests are centered on the use of nanotechnology for drug delivery. In particular, our work focuses on developing formulation solutions for poorly soluble and poorly bioavailable drugs and drug candidates. Several active molecules showing promising *in vitro* therapeutic activity, including anti-cancer properties, suffer from poor solubility and bioavailability. In order to address this limitation, we exploit the self-assembly behavior of polymers for the formation of controlled-size and stable nanoparticles of cancer drugs, which exhibit improved bioavailability. Moreover, in the case of cancer drugs, nanoparticles offer enhanced delivery to tumors through the enhanced permeability and retention (EPR) effect attributed to nanoparticles.

We use a recently developed technique termed Flash NanoPrecipitation (FNP) for the production of controlled size, high yield nanoparticles of anti-cancer drugs.

In this talk, an overview of FNP will be presented, as well as several examples demonstrating control of particle size, particle stability, and *in vivo* efficacy in the case of the anti-cancer paclitaxel. General strategies for the formulation of actives *via* FNP will be discussed.

Walid Saad

Dr. Walid Saad is an assistant professor of chemical engineering at the American University of Beirut (AUB). Since joining AUB in the fall of 2010, Walid's research interests have been mostly focused on nanotechnology, pharmaceuticals, and the environment. He is actively involved in several interdisciplinary projects spanning the School of Medicine, the Chemistry department, and the Biology department at AUB.

Prior to joining AUB, Walid assumed the position of senior scientist at Merck, New Jersey, USA. For the past four years, he worked on the development of parenteral formulations for drug candidates in the oncology area. While in this role, he provided support for the successful filing and regulatory approval of the brain tumor treatment drug Temozolomide Powder For Injection 100 mg/vial in the US, Canada, and Europe.

Prior to his involvement in the pharmaceutical industry, Walid obtained his Ph.D. in chemical engineering working with Prof. Robert Prud'homme at Princeton University, New Jersey, USA. His graduate work focused on the design of novel polymer-based nanoparticle formulations for the controlled delivery of active agents.

Walid holds a B.S. in chemical engineering from the University of Minnesota, and a B.S. in chemistry from the Lebanese American University in Beirut, where he worked on his senior project under the supervision of Dr. Ahmad Kabbani.

Large scale self-organized nano-patterning under ion-beam irradiation: Experiment, theory and potential applications

Charbel Madi

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Abstract:

The use of energetic ion beams has great promise for morphology control in materials synthesis and processing at sub-lithographic length scales. When materials are irradiated at energies low enough that the principal phenomena are observed at the surface rather than in the bulk, several interesting phenomena are observed. Under certain irradiation conditions, ion beams lead to ultra-smoothing, which has important potential applications in fields ranging from X-ray optics to plasmonics to surgery. Under other conditions, one observes self-organized arrays of nanoscale surface features, with potentially unique applications to electronics, optoelectronics, or spintronics. Although both phenomena are potentially rich sources of technological application, currently the fundamental physical mechanisms determining behavior are not well understood. In this talk, I will discuss the latest experimental and theoretical contributions to this field as well as potential applications currently in development at AUB.