Femtosecond energy harvesting and storage

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Christoph Harder

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Dr. Christoph Harder received the Electrical Engineering Diploma from the ETH in 1979 and the Master and PhD in Electrical Engineering in 1980 and 1983 from Caltech, Pasadena, USA. He is co-founder of the IBM Zurich Laser Diode Enterprise which pioneered the first 980nm high power pump laser for telecom optical amplifiers.
He has been managing during the last few years the high power laser diode R&D effort in Zurich expanding, working closely with a multitude of customers, the product range into 14xx pumps as well as 808 and 9xx multimode pumps for industrial applications. He has published more than 100 papers and 20 patents and has held a variety of staff and management positions at ETH, Caltech, IBM, Uniphase, JDS Uniphase, Nortel and Bookham.

Welcome and Moderation

Prof. Dr.
Hubert Girault

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Hubert Girault heads the Laboratory of Analytical and Physical Electrochemistry.
His research interests include the study of charge transfer reactions at soft interfaces including using ultrafast spectroscopic techniques, the development of electrophoretic separation techniques for proteomics, and the development of functional ionisation emitters for mass spectrometry.
He is the co-author of more than 400 publications.

Femtosecond energy harvesting and storage: An Overwiew
This talk presents the alternative that optical antennas can provide to design a new generation of photovoltaic devices that do not rely on p-n junctions. The concept of optical rectification will be introduced and the industrial challenges presented. In a second part, we shall present the basis of the photo-electrochemical production of solar fuels.

Prof. Dr.
Demetri Psaltis

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Demetri Psaltis was educated at Carnegie-Mellon University where he received the Bachelor of Science degree in Electrical Engineering and Economics in 1974, the Master's in 1975, and the PhD in Electrical Engineering in 1977. In 1980, he joined the faculty at the California Institute of Technology, Pasadena, California. He served as Executive Officer for the Computation and Neural Systems department from 1992-1996. From 1996 until 1999 he was the Director of the National Science Foundation research center on Neuromorphic Systems Engineering at Caltech. He was director of the Center for Optofluidic Integration at Caltech. In the beginning of 2007, he moved to the Ecole Polytechnique Fédérale de Lausanne, Switzerland where he is professor and director of the optics laboratory and the dean of the school of engineering.

Optofluidics for Solar Energy
Optofluidics refers to a class of devices and techniques that combine optics and fluidics. Biophotonics has been a major application of optofluidics partially because in biology we normally use light to make measurements of entities suspended in liquids. Therefore biophotonics naturally combines fluids and optics. The same thing is true in the field of solar fuels where generally chemicals in liquid form are exposed to sunlight which catalyzes or thermally accelerates a chemical reaction that generated useful fuels. The design of a solar fuel system requires the simultaneous optimization of the optical and fluidic properties of the system. We will discuss how optofluidic solar fuel systems [1] that rely on microstructured components with dual, optical and fluidic functionality can improve the fuel generation efficiency.

[1] Erickson D, Sinton D, Psaltis D, Optofluidics for energy applications, Nature Photonics, Vol. 5, pp. 583-590, October 2011

Prof. Dr.
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Jacques-Eduard. Moser is titular professor of physical chemistry since 2005 at the Ecole Polytechnique Fédérale de Lausanne (EPFL). He graduated in 1982 in chemical engineering and earned in 1986 his PhD at EPFL under the guidance of Michael Grätzel. He joined then the Eastman-Kodak Corporate Research Laboratories in Rochester (NY, USA). He was appointed lecturer at EPFL in 1992 and was awarded the habilitation in 1998.

Third-generation photovoltaic cells: Beyond the present state-of-the-art
Present 1st and 2nd generation photovoltaic products based on silicon and thin films technologies are hampered by a ~33% power conversion efficiency limit and hardly allow for direct generation of electricity at a capital cost inferior to 1 $/ Wp. The energy conversion potential of advanced approaches for improving photovoltaic performance based on recent fundamental findings will be outlined.

Prof. Dr.
Natalia Del Fatti

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Natalia Del Fatti is professor at University Lyon 1 where she co-founded the FemtoNanoOptics group. She has more than 15 years experience in plasmonics and ultrafast dynamics of metals and nanomaterials, and pioneered the field of linear and nonlinear optical spectroscopy of single nano-objects. Her current research interests include non-linear optics, linear and nonlinear plasmonics and nano-physics (nano-optics, -electronics, -acoustics and -thermics).

Ultrafast nonlinear plasmonics in metallic and hybrid nanoparticles
Metal and metal-based hybrid nanoparticles are very promising for linear and nonlinear plasmonic applications. They also raise many fundamental questions on the impact of confinement and material interfacing on their electronic and vibrational responses. Ultrafast optical nonlinearity of a single metal nanoobject and charge transfer in metal-semiconductor nanoparticles will be discussed on the bases of experimental studies performed using femtosecond and spatial modulation spectroscopies.

Dr. Tony Kaiser

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Tony Kaiser graduated from University of Zürich with a PhD in Physical Chemistry. During his professional career he held several R&D management positions with BBC, ABB and Alstom. Since 1st June 2010, he is with Consenec AG, Baden-Dättwil. His current functions include consultancy for Alstom Power, President of the Federal Energy Research Commission (CORE), and Director of the *Energie Trialog Schweiz*.

Challenges of the nuclear power phase-out in Switzerland
Substituting the 40% share of nuclear power in Switzerland's electricity supply while at the same time adhering to the CO2 emissions reduction targets, poses a big challenge to the country in terms of renewable power growth. Strong efficiency gains are expected to lead to a stabilization of electricity consumption and to a further *decoupling* of energy growth from economic growth.

Dr. Jan Dorn

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Jan Dorn studied chemistry at the Philipps-Universität in Marburg where he received his diploma. The topic of his diploma thesis in the group of Prof. Motzkus was "Two-photon-induced cleavage of coumarin dimers using femtosecond and nanosecond pulses" where he studied the non-linear photochemistry of organic compounds which can be used as linkers for drug delivery in ophthalmology. For the work on his doctoral thesis he moved to the Max-Planck-Institute for Polymer Research in Mainz where he received his doctor's degree in 2010. His scientific focus was on single molecule fluorescence microscopy and single particle tracking in biomimetic polymer membranes. Since 2010 Jan Dorn is a project leader at the Centre for Applied Nanotechnology in the area of nanostructured materials for photovoltaics.

Nanomaterials for energy conversion and energy harvesting
Nanostrucutred materials open up new fields of applications for energy harvesting and energy conversion. Especially the interactions of light with nanostructured matter of comparable dimensions to the wavelength allow for the observation of effects which can be exploited for energy conversion. The talk presents some of the materials developed by CAN GmbH in the context of optical technologies.

Prof. Dr. Hans Björn Püttgen

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Hans B. (Teddy) Pűttgen holds the Energy Systems Management Chair at the. Upon his arrival at EPFL, in April 2006, he also became the inaugural Director of the Energy Center at EPFL.

Future of PV in Switzerland: Policy and incentives
The Energy Center is a university-wide and cross-disciplinary organization with the responsibility of coordinating all R&D activities on campus related to energy. EPFL has a very broad energy portfolio located within major laboratories in all five major Facultés (Schools), ranging, for example, from electric power production, distribution and end use to controlled fusion, from hydropower generation to photovoltaics, from building technologies to thermal turbo-machinery. The Energy Center also aims to incorporate R&D activities related to economics of energy and public policy.