HL 79: Photovoltaics: General Aspects

Time: Thursday 10:30–12:00 Location: EW 201

HL 79.1 Thu 10:30 EW 201

First principles study of photoinduced charge separation in an artificial light harvesting complex — •Carlo Andrea Rozzi[1], Sarah Maria Falke[2], Nicola Spallanzani[1], Angel Rubio[3], Elisa Molinari[1], Daniele Brida[4], Margherita Maiuri[4], Giulio Cerullo[4], Heiko Schramm[2], Jens Christoffers[2], and Christoph Lienau[2] — [1]CNR - Istituto Nanoscienze, Modena, Italy — [2]Carl von Ossietzky Universität, OIdenburg, Germany — [3]Fritz-Haber-Institut der MPG, Berlin, Germany — [4]Politecnico di Milano, Italy

Nature has developed sophisticated and highly efficient molecular architectures to convert sunlight energy into chemical energy. It is known that the primary steps, specifically both energy and charge transfer, occur on extremely fast time scales. These processes have traditionally been interpreted in terms of the incoherent kinetics of optical excitations and of charge hopping, but recently signatures of quantum coherence were observed in energy transfer in photosynthetic bacteria. We have studied a carotene-porphyrin-fullerene triad, which is a prototypical artificial reaction center, by Time-dependent Density Functional Theory simulations of the quantum dynamics. In combination with high time resolution femtosecond spectroscopy our results provide clear evidence that the driving mechanism of the charge separation process is a quantum correlated wavelike motion of electrons and nuclei on a timescale of few tens of femtoseconds, thus establishing the role of quantum coherence in artificial light harvesting.

HL 79.2 Thu 10:45 EW 201

Towards intermediate-band formation in solar cells with AlGaInAs quantum dots — •Tristan Braun[1], Christian Schneider[1], Stefan Kremling[1], Nadezda V. Tarakina[2], Maxwell Adams[1], Matthias Lermer[1], Stephan Reitzenstein[1,3], Lukas Worschech[1], Sven Höfling[1], Alfred Forchel[1], and Martin Kamp[1] — [1]Technische Physik, Universität Würzburg, Germany — [2]Experimentelle Physik III, Universität Würzburg, Germany — [3]Present adress: Institute of Solid State Physics, Technische Universität Berlin, Germany

Increasing the efficiency of state-of-the-art solar cells is considered as one of the most important challenges nowadays in the quest for sustainable energy resources. In this work, we report on a solar cell design based on the intermediate-band approach, which theoretically allows to reach efficiencies of up to 63% for single intermediate-band cells. Our test device comprises spectrally detuned AlGaInAs/AlGaAs and InAs/GaAs quantum dot (QD) layers in an AlGaAs p-i-n structure, leading to a spectrally large absorption range. By adjusting the material composition in the different QD layers, we can cover a spectral range from 680 to 1150 nm by QD absorption. In addition, we propose a device design allowing for the generation of an hybridized QD subband for the application in future intermediate band solar cell devices with increased efficiency.

HL 79.3 Thu 11:00 EW 201

Laser structuring of solar glasses for light management — •Stephan Krause[1], Paul-Tiberiu Miclea[1,2], Gerhard Seifert[1,2], and Stefan Schweizer[1,3] — [1]Fraunhofer Center for Silicon Photovoltaics CSP, Walter-Hülse-Str. 1, 06120 Halle (Saale) — [2]Institute of Physics, Martin Luther University of Halle-Wittenberg, Heinrich-Damerow-Str. 4, 06120 Halle (Saale) — [3]Centre for Innovation Competence SiLi-nano®, Martin Luther University of Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, 06120 Halle (Saale)

Glass is an important component in solar modules. Structuring of the glass surface offers a fundamental approach to increase solar module efficiency. Ultra-short laser pulses allow for a flexible and innovative micro-structuring of the glass surface for light management. The micro-structures analyzed for light management were 2D-grids consisting of many fine, parallel and equally spaced grooves. Transmission and scattering measurements showed that the untreated solar glass has an average transmittance of 85% in the spectral range from 400 nm to 1100 nm; the glass showed no significant light scattering (less than 1%). Laser structuring, however, leads to a significant increase in the forward scattering whereas the total transmittance remains almost unchanged. For 1030 nm fs-laser structuring, the forward scattering of the 2D-grid structures with a line spacing of 50 μm, 25 μm and 10 μm could be gradually increased to more than 20%, 40% and nearly 80%, respectively, for the spectral range from 400 to 1100 nm.

HL 79.4 Thu 11:15 EW 201

Application of series resistance imaging techniques to $Cu(In,Ga)Se_2$ solar cells — •Felix Daume[1,2], Andreas Rahm[1], and Marius Grundmann[2] — [1]Solarion AG, Ostende 5, 04288 Leipzig, Germany — [2]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, 04103 Leipzig, Germany

$Cu(In,Ga)Se_2$ thin film solar cells on flexible polyimide foil enable innovative applications as well as a fabrication in a continuous roll-to-roll process and currently reach efficiencies up to 18.7 %. In order to optimize the solar cell efficiency via reduction of inherent losses in the cell, a spatially resolved access to parameters characterizing ohmic losses, i.e. the series resistance, is highly advantageous.

We apply two different interpretation methods from the literature to our material system which enable the calculation of a mapping of the series resistance from electroluminescence images taken at different voltages. Both methods will be demonstrated, compared and discussed on an example. Furthermore, the benefit of such a method for the characterization of solar cells under accelerated aging conditions (damp heat) which is important for the estimation of the long-term stability will be shown.

HL 79.5 Thu 11:30 EW 201

The band offsets of Cu_2O/ZnO and Cu_2O/GaN heterointerfaces — •Benedikt Kramm, Andreas Laufer, Daniel Reppin, Achim Kronenberger, Philipp Hering, Angelika Polity, and Bruno K. Meyer — 1. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

As known from Minemoto et al. [1] the band offsets of heterostructures affect the electron transport in device applications. Using photoelectron spectroscopy (XPS) we investigate the band alignments of the heterointerfaces mentioned above. We found a conduction band offset (CBO) value of 0.97 eV for Cu_2O/ZnO and 0.24 eV for Cu_2O/GaN. The large CBO between ZnO and Cu_2O will very likely result in low photovoltaic power conversion efficiencies as is the current status of Cu_2O/ZnO solar cells. However, the low conduction band offset of Cu_2O/GaN making GaN a more suitable candidate for the front contact of Cu_2O based solar cells.

[1] Minemoto, T. et al., Solar Energy Materials and Solar Cells, **67**(1-4):83-88(2001)

HL 79.6 Thu 11:45 EW 201

Degradation Analysis of Polymer Solar Cells by Imaging Methods — •Harald Hoppe — Institut für Physik, TU Ilmenau, 98693 Ilmenau, Deutschland

Accelerated progress in device performance and processing technology of organic solar cells opens up the opportunity of their commercialization. Besides high performance, good processability and prospected low production costs, the photovoltaic devices require long term stability in order to face practical applications. Hence investigations of device degradation and improvements of their stability are one of the most actual research topics that need to be addressed. It is shown that imaging methods such as luminescence or thermography imaging are powerful tools to learn about the dominant degradation mechanisms of to dates state-of-the-art polymer solar cell architectures. An overview of most probably origins for device failure is presented, which provides valuable hints for constructive device stabilization.