AKE 13: Erneuerbare Energie: Solarenergie und Integration

Time: Wednesday 16:45–19:00 Location: EW 201

Invited Talk AKE 13.1 Wed 16:45 EW 201

Dye-based solar cells - recent advances and specific results for merocyanine dyes — •Klaus Meerholz[1], Vera Steinmann[1], Nils Kronenberg[1], Martin Lenze[1], Hannah Buerckstuemmer[2], and Frank Wuerthner[2] — [1]University of Cologne — [2]University of Wuerzburg

Organic and dye-based solar cell R&D is rapidly progressing. The talk will give an overview of the status of dye-based solar cell R&D and address in particular merocyanine dyes as electron donor compounds in small-molecule bulk-heterojunction solar cells. Most simple-structured merocyanines have the major advantage of being soluble as well as thermally stable and thus sublimable, which leads to more flexibility in the device processing. Recently, we presented a direct comparison of highly efficient solution- and vacuum-processed bulk heterojunction solar cells based on merocyanines with a simple device stack consisting of only three organic layers. In this study, the most efficient devices exhibited an efficiency of 4.9%. Following this, we succeeded in optimizing the vacuum-processed merocyanine solar cells while maintaining the same simple layer stack. Here, we reported efficiencies up to 6.1%. Due to their remarkably high and easily tunable absorption, merocyanine dyes are also promising candidates for tandem structures. Very recently, we successfully implemented merocyanine dyes in tandem-cell devices. High efficiencies up to 4.7% were achieved by simply connecting two identical single-cells in series. These devices also displayed remarkably high open-circuit voltages beyond 2V. The prospects for applications will be discussed. (Der Vortrag wird auf Deutsch mit englischsprachigen Folien gehalten)

AKE 13.2 Wed 17:15 EW 201

Ab initio study of organic solar cell devices — •Amaury M Souza, Ivan Rungger, and Stefano Sanvito — Trinity College Dublin, Dublin 2, Republic of Ireland

Since Grätzel and O'Regan published their remarkable paper in 1991[1], photovoltaic solar cells have attracted significant attention due to the demand for renewable energy resources. The capability of converting light into electrical energy with lower cost and higher efficiency than the solid-state devices are the greatest challenge of the area. The so-called dye-sensitized Solar Cells (DSCs) consist of using organic molecules as the optical active part of the device, sandwiched between a transparent semiconductor and a counter electrode. They have been studied both theoretical[2] and experimentally[3] showing a promising alternative to enhance the efficiency and cost.In the present work we carried out *ab-initio* calculations to study the charge transport properties of solar cells devices. We have investigated several donor-acceptor organic molecules sandwiched between TiO_2 and Au electrodes by means of NEGF formalism implemented on SMEAGOL code. In order simulate the exciton creation, a constrained-DFT method (C-DFT) was applied and the transport properties of the whole system was calculated for two different electronic configurations, namely, the DFT ground state and the constrained excited state.

[1] B. O'Regan and M. Gratzel. *Nature*, 353, 737, 1991.
[2] Na Sai et. al.*PRB*, 121309, 83, 2011.
[3] Yongbo Yuan et. al. *Nature Materials*, 296, 10, 2011.

AKE 13.3 Wed 17:30 EW 201

Research of photocatalytic mechanism using tunable metal/semiconductor nanosized heterostructures — Zhibing Zhan[1,2], Ranjith Vellacheri[1,2], Liaoyong Wen[1,2], Huaping Zhao[1,2], and •Yong Lei[1,2] — [1]Fachgebiet 3D-Nanostrukturierung, Institut für Physik & Zentrum für Mikro- und Nanotechnologien (ZIK MacroNano), Technische Universität Ilmenau, 98693 Ilmenau, Germany. — [2]Institut für MaterialPhysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

Highly ordered metal nanodots were synthesized on semiconductor ZnO single crystals using ultrathin alumina membranes (UTAMs) as masks. The dimensions of the metal nanodots have been precisely tuned by the diameters of the pores in UTAMs. Electrical measurements illuminated the types of the nanosized heterostructures between the metal nanodots and ZnO single crystal substrates. Photocatalytic researches further indicated that the kinds and dimensions of the metal nanodots determined the light conversion efficiency of the heterostructures. By optimizing the parameters of the metal nanodots, light conversion efficiency could be enhanced significantly. This work clarified some crucial issues of improving the light conversion efficiency using nanosized heterostructures, which provide guidance for future design of novel metal/semiconductor heterostructures.

AKE 13.4 Wed 17:45 EW 201

Entwicklung innovativer Radarpositionsmesser für Solarturm-Heliostate — •Markus Sauerborn[1], Jasmin Rubart[2], Bernhard Hoffschmidt[1], Helmut Essen[2], Stefan Sieger[2], Joachim Göttsche[1] und P. Hilger[1] — [1]Solar-Institut Jülich, Heinrich-Mußmann-Str. 5, 52428 Jülich — [2]Fraunhofer-Institut für Hochfrequenzphysik und Radartechnik, Neuenahrer Str. 20, 53343 Wachtberg

Das Heliostatenfeld eines Solarturmkraftwerkes erfordert eine genaue Nachführung. Die aktuelle Technik befindet sich jedoch noch in einem relativ frühen Entwicklungsstadium. Ziel einer aktuellen vom BMU geförderten Machbarkeitsstudie am Solar-Institut Jülich und Fraunhofer-Institut für Hochfrequenzphysik und Radartechnik ist die Untersuchung, Radar als Positionsmesser für Solarturm-Heliostate zu nutzen. Ein miniaturisiertes System mit Sender und Empfänger soll mit geeigneter Analysesoftware helfen, die Investitionen zu senken sowie die Effizienz der Anlage zu steigern, indem ein kostengünstigeres aber genaueres System für die Nachführung eingesetzt wird. Zurzeit werden unter anderem Tests am solarthermischen Versuchskraftwerk in Jülich durchgeführt. Dazu werden von der Forschungsplattform des Solarturms Spiegel im Heliostatenfeld mit einem Millimeterwellen-Radar des FHR abgetastet. Das reflektierte Signal wird für die Auswertung durch das FHR mit hochwertiger Sensorik aufgezeichnet und nachträglich ausgewertet. Das SIJ führt neben den Radarmessungen eigene Präzisionsmessungen u. a. zusammen mit Lasern und hochauflösenden Kamerasystemen durch, um die Eignung der Radartechnik gegenüber alternativen Messsystemen vergleichen zu können.

AKE 13.5 Wed 18:00 EW 201

Variabilität erneuerbarer Energien und Wege zu einer Minderung des Regelbedarfs — •Tobias Tröndle, Ulrich Platt und Werner Aeschbach-Hertig — Institut für Umweltphysik, D-69120 Heidelberg

Die Verfügbarkeit erneuerbarer Energien (EE) wie solare Einstrahlung und Wind fällt nicht per se mit der Elektrizitätsnachfrage zusammen. Die charakteristischen Frequenzen von Wetterereignissen sowie deren zeitliche und räumliche Korrelationen, die sich aus Zeitreihen von Wetterdaten ermitteln lassen, sind somit wichtige Randbedingungen einer regenerativen Energieversorgung.

Um eine sichere Elektrizitätsversorgung zu gewährleisten, muss bei einem hohen Anteil an EE zusätzlich Regelenergie oder Energiespeicherkapazität bereitgestellt werden. Diesbezüglich technisch wie ökonomisch relevante Fragen nach Regelbedarf, Gradienten der Residuallast und Einsatzhäufigkeit von Ausgleichsmaßnahmen, können mit Energieversorgungsmodellen untersucht werden. Aber auch Ansätzen zur Minderung des Regel- und Speicherbedarfs kann so nachgegangen werden. Speziell untersucht wird hierbei die Abhängigkeit des Speicher- bzw. Regelenergiebedarfs vom gewählten Energiemix, der Überkapazität an Kraftwerksleistung gegenüber der im Jahresmittel nachgefragten Leistung und von der Größe des Verbundnetzes.

AKE 13.6 Wed 18:15 EW 201

PV and Wind Power - Complementary Technologies — •Ann-Katrin Gerlach[1], Daniel Stetter[2], and Christian Breyer[3] — [1]Universität Kassel — [2]Deutsches Zentrum für Luft- und Raumfahrt (DLR) — [3]Reiner Lemoine Institut gGmbH

PV and wind power are the major renewable power technologies in most regions on earth. Depending on the interaction of solar and wind resources, PV and wind power industry will become competitors or allies. Time resolved geospatial data of global horizontal irradiation and wind speeds are used to simulate the power feed-in of PV and wind power plants assumed to be installed on an equally rated power basis in every region of a 1°x1° mesh of latitude and longitude between 65°N and 65°S. An overlap of PV and wind power full load hours is defined as measure for the complementarity of both technologies and identified as ranging between 5% and 25% of total PV and wind power feed-in. Critical overlap full load hours are introduced as a measure

for energy losses that would appear if the grid was dimensioned only for one power plant of PV or wind. In result, they do not exceed 9% of total feed-in but are mainly around 3% - 4%. Thus the two major renewable power technologies must be characterized by complementing each other.

AKE 13.7 Wed 18:30 EW 201

Comparison of different energy storage systems for renewable energies on a Caribbean island — •Philipp Blechinger[1], Markus Hlusiak[1], Jan Meiss[1], Kristina Bognar[2], and Christian Breyer[1] — [1]Reiner Lemoine Institut gGmbH, Ostendstraße 25, 12459 Berlin, Germany — [2]Technische Universität Berlin, Institut für Energietechnik, Fasanenstraße 89, 10623 Berlin, Germany

The Caribbean has a great technological and economic potential for using renewable energies for power generation based on the natural conditions.

In case of generation from fluctuating sources such as solar and wind, the storage of excess electricity is necessary to cover periods of insufficient power generation. To decrease the share of diesel GenSets in the energy supply system more renewable energy and storage capacity is needed. The task of our study is to find the techno-economic optimized energy supply system including energy storage systems. Here we analyze the small Caribbean island Petite Martinique (1000 inhabitants), Grenada. Sealed lead-acid batteries are compared to vanadium redox flow batteries in different combinations with photovoltaics and wind turbines. Due to the hot climate a cooled environment has to be considered for the lead-acid batteries.

Finally three scenarios are compared for different configurations of storage in the energy supply system: lead-acid batteries with lifetime of 5 years, with lifetime of 10 years and vanadium redox flow batteries. The best scenario for different shares of renewable energies in the energy supply system is shown.

AKE 13.8 Wed 18:45 EW 201

Sustainable Growth Potential of Photovoltaic Systems in a Global Perspective — •Christian Breyer — Reiner Lemoine Institut gGmbH, Ostendstr. 25, 12459 Berlin

The photovoltaic (PV) energy technology has the potential to contribute to the global energy supply on a large scale. This potential can only be realised if sustainable and highly competitive PV economics are achieved. An integrated economic PV market potential assessment is presented consisting of grid-parity and fuel-parity analyses for the on-grid markets and an amortization analysis for rural off-grid PV markets. All analyses are mainly driven by cost projections based on the experience curve approach and growth rates for PV systems and electricity and fossil fuel prices for the currently used power supply. A total economic PV market potential of 2,800 GW to 4,300 GW is derived for the year 2020. 600 GW to 1,600 GW of cumulated installed PV capacity is estimated for the year 2020, depending on scenario assumptions. In conclusion, PV is on its way to become a highly competitive energy technology.