AKE 1: Konzepte und Technologien

Time: Monday 11:00–12:45 Location: GER/038

Invited Talk AKE 1.1 Mon 11:00 GER/038

Zellulare Energiesysteme – Zukunft der Energietechnik ? — •Joachim Seifert[1] und Peter Schegner[2] — [1]TU Dresden, Institut für Energietechnik — [2]TU Dresden, Institut für Elektrische Energietechnik und Hochspannungstechnik

Energetische Systeme sind aktuell meist hierarchisch organisiert und bestehen aus großtechnischen Systemen die zentral unterschiedliche Primärenergien in Sekundärenergien wandeln, die dann den Verbrauchern über Leitungssysteme zugeführt werden. Durch die Energiewende wandeln sich diese unidirektionalen Systeme zu multidirektionalen Systemen. Consumer werden zu Prosumern, wodurch eine andere Systemarchitektur entsteht. Das Konzept der zellularen Energiesysteme besitzt zur Einbindung von dezentral erzeugten erneuerbaren Energien deutliche Vorteile, da auf lokaler Ebene schon versucht wird einen Ausgleich unterschiedlicher Verbrauchs- und Erzeugungswerte zu erreichen. Orientieren kann man sich hierbei an dem biologischen Konzept einer Zelle. Im energetischen Kontext ist die Zelle hierbei jedoch nicht scharf definiert. Sie kann als ein Gebäude, ein Quartier oder eine Region aufgefasst werden. Im Vortrag soll der Ansatz des zellularen Energiesystem detailliert erläutert werden. Die betrifft die systemischen Anforderungen, das Konzept von Energietrendbändern sowie die zum Betrieb notwendige Kommunikationstechnik. Abgerundet wird der Vortrag durch Praxisbeispiele.

AKE 1.2 Mon 11:30 GER/038

Numerical Simulation of the coating process for organic photovoltaics — •Fabian Gumpert[1], Annika Janssen[1,2], Andreas Distler[2], Christoph J. Brabec[2], Hans-Joachim Egelhaaf[2], and Jan Lohbreier[1] — [1]Nuremberg Institute of Technology, Nuremberg, Germany — [2]Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany

In various industrial applications, the doctor blading process is a well-established technique to coat thin films. In the context of organic photovoltaics, functional layers like electrodes, active materials, and interfacial layers are printed using this technique. For the performance and lifetime of the final photovoltaic devices, the thickness precision and uniformity of the individual layers is crucial.

Computational Fluid Dynamics (CFD) simulations and experiments are used to study the effect of various parameters on the film formation during doctor blading. For example, a numerically simulated correlation between coating speed and wet film thickness is established and found to match the experimental findings.

With the help of these CFD simulations, process parameters and resulting film thicknesses can be predicted based on simple fluid characteristics such as viscosity and surface tension. Furthermore, the observed decrease in the wet film thickness over printed distance, which relates to the decreasing volume in the meniscus, can be compensated by a calculated acceleration of the applicator during the coating process to drastically increase the distance range of homogeneous coating by doctor blading.

AKE 1.3 Mon 11:45 GER/038

Multiphysical simulation of the temperature distribution in a PEM-Fuel Cell — •Lara Kefer, Fabian Gumpert, Susanne Thiel, Maik Eichelbaum, and Jan Lohbreier — Nuremberg Institute of Technology, 90489 Nuremberg, Germany

Polymer electrolyte membrane fuel cells (PEM-FC) are a key technology for converting chemical energy from - ideally green - hydrogen into electrical energy. However, the electrochemical processes in a fuel cell also generate heat, which is crucial for the cell's performance and difficult to detect by experiments.

The heat generated in these exothermic chemical reactions and the external heating for the operating temperature were numerically simulated. The temperature field affects the relative local humidity, which has a strong influence on the local and global performance of the cell. Therefore, the three-dimensional temperature distribution was modelled, and the resulting voltage-current curves were computed. The latter are commonly used to characterize the properties of a fuel cell as a source of electric power.

The simulations show a temperature increase of the inner layers of the fuel cell due to the electrochemical reactions. The temperature of the cooler working gases (H2, O2) approaches the externally defined operating temperature of the fuel cell. This effect can also be seen in experimental data. The simulated U-I characteristics have the same overall shape as the experimentally determined characteristics and both reveal a decrease in the performance of the cell at higher temperatures.

AKE 1.4 Mon 12:00 GER/038

Photocatalytic conversion of carbon dioxide into methane for solar fuel production using a TiO2 functionalized thin-film micro-reactor — •Sebastian Thalheim — Fraunhofer ISE, Freiburg, Deutschland

The increasing concentration of greenhouse gases in the Earth's atmosphere is a major contributor to climate change. Carbon dioxide, a key greenhouse gas, is produced by fossil fuel combustion and industrial processes. The reverse combustion reaction offers a useful approach for converting carbon dioxide into hydrocarbons, such as methane, for use as a renewable fuel source and therefore contributing to a closed-carbon-dioxide cycle. However, the reverse combustion reaction requires significant amounts of energy for activation. Photocatalysis, which uses light to reduce the activation energy required, offers a potential solution to this challenge. By using renewable energy to drive the photocatalytic reaction, we can minimize the carbon footprint of the conversion process.

We propose a setup for the continuous conversion of carbon dioxide into methane using a photocatalytic TiO2 functionalized thin-film micro-reactor. We aim to identify the most influential parameters and optimize the reactor design and photocatalytic material to maximize Solar-To-Gas efficiency. This approach has the potential to make the conversion process more efficient and scalable. A life-cycle analysis will be performed to assess ecological sustainability, economic scalability, and the potential for carbon capture and usage of this emerging technology.

AKE 1.5 Mon 12:15 GER/038

Development of a loss model for dynamic inductive charging — Fabian Gumpert[1], •Michael Schmidt[1,2], Armin Dietz[1,2], and Jan Lohbreier[1] — [1]Nuremberg Institute of Technology, 90489 Nuremberg, Germany — [2]Institute ELSYS, Nuremberg, Germany

The electrification of vehicles is a promising approach to reduce the carbon footprint of the mobility sector. However, this approach still faces several challenges, for instance the limited range - or high battery weight - of electric vehicles. A possible solution to this limitation is an electrified road system (ERS) where coil segments are integrated into the road. An electric vehicle with a receiver module can charge inductively its battery while driving on these roads.

Analytical and numerical (Finite-Element-Method) simulations are used to model the ERS and the inductive charging of the vehicle to investigate the occurring losses. In detail, FEM simulations are used to investigate the efficiency of the power transfer from the transmitter coil within the ERS to the receiver coil, moving onboard the vehicle, under various conditions.

The coil segments in the ERS are supplied with a high-frequency square-wave voltage. To investigate all loses of the system it is necessary to develop a measurement device. The fundamental frequency of the voltage signal is roughly 90 kHz. The device can measure up to one MHz in order to detect high harmonics of the fundamental frequency. The concept of the measurement setup and first experimental results, which demonstrate the capability of the setup, are presented.

AKE 1.6 Mon 12:30 GER/038

Gigantisch große Hydrokavernenspeicher in Braunkohleabbaustätten zur nahezu verlustfreien Überbrückung von Kurzzeitschankungen in Energieerzeugung und Verbrauch — •Horst Schmidt-Böcking[1], Gerhard Luther[2] und Joachim Schwister[3] — [1]Institut für Kernphysik, Universität Frankfurt, Max-von-Laue Str.1, 60438 Frankfurt — [2]FSt. Zukunftsenergie (FZE), Experimentalphysik - Bau E26, Universität des Saarlandes, 66123 Saarbrücken — [3]Technischer Beigeordneter a.D., Berrenrather Str. 9, 50169 Kerpen

Die Energiespeicher-Technologie „Grüner Wasserstoff“ alleine ist nicht in der Lage, bei nahezu 100%iger Erzeugung von der in Deutschland für die Energiewende benötigten elektrischen Energie die sogenannten Spitzen in der Energieerzeugung am Tage (wenn Sonne und Wind überdurchschnittlich viel Energie liefern) verlustfrei zu speichern oder nachts verlustfrei Strom zu liefern. In diesen Nachtflauten muss man dann Wasserstoff rückverstromen, wobei der Wirkungsgrad für die nutzbare Rückverstromung bezogen auf den primären Strom bei nur ca. 30% liegt. Durch eine Kombination von „Grüner Wasserstoff Technologie“ mit einem Hydrokavernenspeicher (ca. 0,5 TWh pro Speicherzyklus oder größer) als Kurzzeitspeicher (Stunden, Tage), kann eine wesentlich verlustärmere Technologie zur Energiespeicherung in Deutschland aufgebaut kann, die die Verluste weitgehend eliminiert und damit Elektrizität von hunderten TWh/pro Jahr zu sehr niedrigen Kosten für die Industrie und auch für den kleinen Verbraucher nachhaltig bereit hält.

In den zu flutenden Braunkohleabbaustätten (z.B. Hambach, Garzweiler, Schleenhain, Cottbus etc.) kann man Hydrokavernenspeicher von gigantischer Kapazität (z.B. Hambach bis zu 0,5 TWh pro Zyklus) errichten. Das Prinzip und der Aufbau eines solchen Kavernenspeichers auf dem Boden einer gefluteten Braunkohleabbaustätte wird im Vortrag besprochen.