TUT 1: Tutorial: Modern Photovoltaics - Techniques beyond Silicon

Chair: Wichard J. D. Beenken, Institut für Physik, Technische Universität Ilmenau

Time: Sunday 16:00–18:30 Location: H2

Tutorial TUT 1.1 Sun 16:00 H2

CdTe thin-film solar cells — •Heinrich Metzner — Institut für Festkörperphysik, FSU Jena, Max-Wien-Platz 1, 07743 Jena

The global industrial production of CdTe solar modules exceeds one Gigawatt per year and so CdTe is probably the most successful thin-film technology of recent years.

In the tutorial, the specific features of the technology are elucidated which make it so competitive. Moreover, the open questions in the materials science of the CdTe-CdS-hetero-structure are discussed and key-issues are identified which are believed to potentially bring the CdTe solar cells to efficiencies well above 20 %.

Tutorial TUT 1.2 Sun 16:30 H2

CIGS thin-film solar cells — •Stefan Paetel — Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden Württemberg (ZSW), Industriestraße 6, 70565 Stuttgart, Germany

This talk covers the current status and understanding of high-efficiency Cu(In,Ga)Se_2 solar cells. Starting with the principal setup of these cells the various parts of the multilayer system will be introduced: substrate, back-contact, absorber, buffer and front contact. This includes the structural, optical and electronic properties of the materials. Furthermore relevant deposition methods are presented along with module manufacturing issues.

Tutorial TUT 1.3 Sun 17:00 H2

Dye-sensitized solar cells — •Sven Rühle — Institute for Nanotechnology and Advanced Materials, Dept. of Chemsitry, Bar Ilan University, Ramat Gan 52900, Israel

Dye-sensitized solar cells (DSSCs) are a low cost alternative to crystalline silicon p-n junction photovoltaic cells. DSSCs consist of a mesoporous nanocrystalline wide bandgap semiconductor (usually TiO_2) that is sintered onto a transparent conducting substrate (TCO). The nanocrystals are covered with a dye-monolayer and the pores are filled with a redox electrolyte which is in contact with a Pt counter electrode. Upon illumination light is absorbed by the dye molecules and electrons are injected from the excited dye state into the TiO_2 conduction band while the dye is regenerated by the electrolyte. Electrons diffuse through the mesoporous film to the TCO front contact while positive charges are transported by the redox species to the counter electrode. In DSSCs efficient charge separation occurs at the TiO_2/dye/electrolyte interface and build-in electrostatic fields play a minor role for cell operation in contrast to p-n junction solar cells. The basic principles of DSSC operation will be reviewed and theoretical efficiency limitations will be discussed.

Tutorial TUT 1.4 Sun 17:30 H2

Organic solar cells based on small molecules — •Moritz Riede — IAPP, Technische Universität Dresden, Germany

In recent years organic solar cells based on polymers or small molecules have received increasing attention from both science and industry, making it a very dynamic field of research. On the one hand, there are a number of open questions on the fundamental physics, e.g. the process of free charge carrier generation. On the other hand, there is the perspective of low cost solar power due to easy solar cell preparation, low-cost materials and processing technologies, and the possibility of producing large-area flexible devices on plastic substrates. Currently there are two main preparation technologies: solution processing and vacuum thermal deposition. This tutorial will focus on the main principles and concepts of the latter one. Despite its limitations to small molecules due to the thermal evaporation process, vacuum deposition has several distinct advantages: small molecules can be purified to a high degree, molecular doping of the organic layers is possible via co-evaporation, the layer thickness can be controlled well and stacked structures, e.g. for tandem solar cells, are easily accessible. Currently, metal-phthalocyanines and C_{60} are used as standard absorbers, but also new and promising materials have been introduced in recent years. Continuous material and device optimisation has lead to certified efficiencies of more than 6% on an device area exceeding 1cm^2. Finally, an outlook on possible production routes is given.

Tutorial TUT 1.5 Sun 18:00 H2

Polymer Solar Cells — •Harald Hoppe — Institut für Physik, Technische Universität Ilmenau, Germany

Milestones in the development of conjugated polymer-based solar cells are reviewed. The presentation will cover an introduction to elementary photo-physical processes and fundamental working principles of polymer solar cells. Furthermore, processes limiting the individual photovoltaic parameters are discussed. Interesting examples of structure-property-relationships on the super-, inter- and intramolecular scale are given and demonstrate the necessity for multi-scale approaches in the optimization of polymer solar cells. Finally, several so far utilized donor-acceptor material systems are briefly reviewed.