MA 1: Tutorial: Energy materials

This tutorial introduces basic physical concepts underlying the microscopic working principles of a broad and diverse range of energy materials ranging from organic solar cells to strong magnets for wind turbines. Leading scientists from various different disciplines – both from academia and industry – will give an exciting overview of the state-of-the art in their specific field of expertise. The topics to be covered include: Electrochemical energy storage and battery research, superstrong magnets and magnetocalorics, dye-sensitized solar cells from the Graetzel cell to hybrid inorganic-organic perovskites, and solar water splitting. We also refer to the parallelly running tutorial on thermoelectricity. All talks are specifically prepared for a broad audience.

Organized by Erich Runge, TU Ilmenau, and Christoph Lienau, Carl von Ossietzky Universität Oldenburg, on behalf of the Semiconductor Physics Division jointly with the Magnetism Division.

Time: Sunday 16:00–18:35 Location: HSZ 403

Invited Talk MA 1.1 Sun 16:00 HSZ 403
Von Lithium zu Lithium-Ionen-Batterien und zurück — •Martin Winter — WWU Münster, Deutschland

Invited Talk MA 1.2 Sun 16:35 HSZ 403
Magnetic materials for green energy applications — •Oliver Gutfleisch — TU Darmstadt, Material Science, Functional Materials — Fraunhofer Project Group Materials Recycling and Resource Strategy IWKS

Due to their ubiquity, magnetic materials play an important role in improving the efficiency and performance of devices in electric power generation, conversion and transportation 1. Permanent magnets are essential components in motors and generators of hybrid and electric cars, wind turbines, etc. Magnetocaloric materials could be the basis for a solid state energy efficient cooling technique alternative to compressor based refrigeration. Any improvements in magnetic materials will have a significant impact in these areas, on par with many *hot* energy materials efforts (e.g. hydrogen storage, batteries, thermoelectrics, etc.).

The talk focuses on rare earth and rare earth free permanent magnet and magnetocaloric materials with an emphasis on their optimization for energy and resource efficiency in terms of the usage of critical elements. The synthesis, characterization, and property evaluation of the materials will be examined briefly having in mind their critical micromagnetic length scales and phase transition characteristics.

Coffee break (10 min.)

Invited Talk MA 1.3 Sun 17:20 HSZ 403
Recent developments of dye sensitized and mesoscopic solar cells — •Toby Meyer — Solaronix SA, Aubonne, Switzerland

The latest results on the Dye Sensitized Solar Cell developments at Solaronix are presented in the international context, both scientifically and economically. Examples include the first application in a 250 m^2 vertical façade at the Swisstech Convention Center (EPFL, Lausanne). Furthermore, we discuss the rapid progress in perovskite-based photovoltaics and show results on Solaronix's novel "perovskite" solid-state mesoscopic solar cells.

Invited Talk MA 1.4 Sun 17:55 HSZ 403
Perspectives of an artificial leaf based on inorganic semiconductors for water splitting: Device structure, interface engineering, catalytic demands — •Wolfram Jaegermann — TU Darmstadt, Instiute of Materials Science, Jovanka-Bontschits-Str. 2, D-64287 Darmstadt

For an effective conversion of solar energy to a chemical fuel a number of elementary processes as well as their coupling to each other must be optimized without severe losses in the number and the chemical potential of the originally generated electron-hole pairs. Light absorption coupled to efficient charge carrier generation and separation may be realized by thin film semiconductor devices - preferentially tandem cells - which may provide broad band quantum efficiencies close to 1. Alternatively, Janus type photocatalysts may be chosen which favour vectorial electron-hole pair transport into opposite directions. Subsequently, H2 (or HC-fuels) and O2 from H2O (and CO2) must be formed by electron and hole transfer reactions with minimized loss of chemical potential. This will only be possible if the involved charge transfer steps are coupled to selective multi electron transfer catalysts. Technologically feasible solutions seem to be possible for water splitting and H2-generation, as we will show with a number of investigations performed recently combining electrochemical investigations with surface science approaches.

Closing remarks