Integration of research on renewable energy into educational programmes on BSc, MSc and PhD levels

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students 784
PhD st. 140

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students 987
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How to develop cross-technology research to optimise the European energy system?
• Organic molecular photovoltaics (polymer-fullerene bulk hybrid junctions with air stable polyazomethines).

In collaboration with Prof. Agnieszka Iwan, a.iwan@iel.wroc.pl - Electrotechnical Institute, Division in Wrocław


**Power conversion efficiencies:** PAZ = 0.56, P3HT = 3.5%, PTB7 = 5.1%

• Measurements of absorption, luminescence, light-induced electron spin resonance and time-resolved photoluminescence in polymer:fullerene blends

Faculty of Physics, University of Warsaw
Prof. Maria Kamińska, Maria.Kaminska@fuw.edu.pl

- Plasmonic structures. Collaboration with Prof. Tomasz Szoplik, tszoplik@mimuw.edu.pl

  Ge wetting layer increases ohmic plasmon losses in Ag film due to segregation, ACS Appl. Mater. Interfaces 7, 8999 (2015)
  Optimum deposition conditions of ultrasmooth silver nanolayers, Nanoscale Research Lett. 9, 153 (2014)

- Calculations within density functional theory. Collaboration with Prof. Jacek Wojtkiewicz, Jacek.Wojtkiewicz@fuw.edu.pl

  Towards designing polymers for photovoltaic applications, a DFT study of polyazomethines with various chemical structures, Solar Energy, submitted.
Equipment at the Faculty of Physics

Ellexsys E580 spectrometer for X- and Q- bands (Bruker) with helium cryostat and various microwave cavities for measurements of magnetic or electric resonances and changes of electrical resistivity. Light-induced polaron spin resonance signals in active layers of organic solar cells are used to study charge transfer process - decisive for the efficiency of solar cells.

Time-resolved photoluminescence measurement setup consists of a tunable Chameleon Ultra laser (Coherent) with 0.13 ps pulse excitation, wavelength range 233 - 1040 nm, ACTON spectrometer (Princeton) and C5680 streak camera (Hamamatsu) with spectral resolution of 0.1 nm, time resolution of 2 ps. Cryostat for measurements at 4 K to 650 K.

Low-current measurements with Keithley 6517B electrometer and Keithley 2600 pico-ammeter with a sensitivity of 0.1 fA. Cryostat for measurements at 4 K to 650 K.

Confocal Raman spectrometer Renishaw inVia Reflex, focal length 250 mm.

ATLAS 0531 Electrochemical Unit & Impedance Analyzer.

E-beam evaporator (Lesker); SEM Sigma (Zeiss); AFM, SNOM, STM (NT-MDT); Spincoater.

Prof. Agnieszka Iwan, Electrotechnical Institute, Division in Wrocław

UV-Vis - Jasco V670 spectrophotometer.
Solar Simulator SS100AAA AM1.5G for current density–voltage measurements.
Solar cells based on TiO\textsubscript{2} and ZnO sensitized with dyes and semiconductor nanoparticles (CdS, CdSe, PbS)

- Defect minimization and morphology optimization in TiO\textsubscript{2} nanotube thin films, grown on transparent conducting substrate, for dye synthesized solar cell application, Thin Solid Films 552, 71 (2012)
- Electrodeposition of Zn(OH)\textsubscript{2}, ZnO thin films and nanosheet-like Zn seed layers and influence of their morphology on the growth of ZnO nanorods, Electrochim. Acta 98, 255 (2013)

Composite materials for the use in photovoltaic cells

• Synthesis of semiconductor-based and conducting polymer materials for photocatalytic applications
  Selective deposition of gold nanoparticles on the top or inside a thin conducting polymer film, by combination of electroless deposition and electrochemical reduction, Electrochim. Acta 122, 267 (2014)

• Perovskite-based solar cells
• Photovoltaic and photoelectrochemical systems

• Search for new electrode materials for fuel cells and biocells

• Charge storage
Electrochemical capacitors

Non-aqueous gel polymer electrolyte with phosphoric acid ester and its application for quasi solid-state supercapacitors, J. Power Sources 274, 1147 (2015)


Integration of solid-state dye-sensitized solar cell with metal oxide charge storage material into photoelectrochemical capacitor, J. Power Sources 234, 91 (2013)

Electrocatalysis

Palladium content effect on the electrocatalytic activity of palladium–polypyrrole nanocomposite for cathodic reduction of oxygen, Electrocatalysis 5, 23 (2014)

Bio-electrocatalysis

Polyaniline-supported bacterial biofilms as active matrices for platinum nanoparticles: enhancement of electroreduction of carbon dioxide, Australian J. Chem. just accepted

Sensors
Electrochemical energy sources

• Sorption of hydrogen on palladium related alloys
  


• Hydrogen storage in new material electrode
  
  Influence of electrolyte composition and temperature on behaviour of AB\textsubscript{5} hydrogen storage alloy used as negative electrode in Ni-MH batteries, J. Power Sources 263, 304 (2014) [AB\textsubscript{5} metal alloy (Ni\textsubscript{4.1}Al\textsubscript{0.2}Mn\textsubscript{0.4}Co\textsubscript{0.45}) is investigated in different electrolytes (LiOH, NaOH, KOH, RbOH, CsOH)].

• Fuel cells
  
  Fuel cell testing of Pt-Ru catalysts supported on differently prepared and pretreated carbon nanotubes, Electrochim. Acta 98, 94 (2013)

• Lithium ion batteries
  
  Li\textsubscript{4}Ti\textsubscript{5}O\textsubscript{12} modified with Ag nanoparticles as an advanced anode material in lithium-ion batteries, J. Power Sources 245, 764 (2014)
Search for new materials

- **Use of porous glassy carbon**
  New high-energy lead-acid battery with reticulated vitreous carbon as a carrier and current collector, J. Power Sources 198, 378 (2012)

- **Electrochemistry of lead**

- **Electrochemistry and spectroscopy of transition metals and their compounds**

- **New anode and cathode catalysts**
  Electrochemical characterization of the surface and methanol electrooxidation on Pt-Rh-Pd ternary alloys, J. Power Sources 196, 3512 (2011)

- **Recycling and utilization of electrochemical power sources.**
XPS and SIMS. X-ray Photoelectron Spectroscopy measures the elemental composition of a surface. Secondary Ion Mass Spectrometry measures the elemental and molecular composition of the top 1 – 2 nm layer of a surface.

XPS measures the elemental composition of a surface at pressures up 20mbar (SPECS).

Multi Pocket Electron Beam Evaporator (SPECS).

DXR™ Raman Microscope high-resolution depth profiling and surface analysis of coatings and thin films in organic and inorganic samples (Thermo Scientific).

Discover D8 X-ray reflectometer - XRR with Cu Kα 0.154 nm source and point detector (Bruker).

Wide angle X-ray diffractometer – XRD with GADDS system and 2D Vantec 2000 detector (Bruker).

SEM + FIB Auriga (Zeiss), TEM + STEM Titan (FEI).

AFM, SNOM, STM – Nanonics.

Spectrophotometers.
We are open for collaboration !!!

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