

## Summary of the 10th IUVESTA summer school on Physics at Nanoscale, 30th May to 4th June 2011, Devet Skal, Czech Republic

The school continued the tradition of the summer schools on physics of nanostructures, surfaces and thin films held every three years in the Czech Republic. The programme of the schools aims at presenting current trends of research at both tutorial as well as state-of-the-art level. The school also connects the areas of fundamental research to the vital areas of technology: nano-electronics, renewable energy and life science applications.

### School overview

The school was organized with a support of IUVESTA and it also was a part of outreach activities of **FP7 project PolySiMode** ([www.polysimode.eu](http://www.polysimode.eu)), project **OPVK 2.4 – Research4Industry**, **CEITEC** ([www.ceitec.eu](http://www.ceitec.eu)) and the **Czech Nanoteam** ([www.fzu.cz/~nanoteam/](http://www.fzu.cz/~nanoteam/)). The school organization also relied on the Czech Vacuum Society and Czech Physical Society and last, but not least, a group of the academic research institutes and universities listed at the school web page ([www.fzu.cz/~iss](http://www.fzu.cz/~iss)).

The school brought together 166 people (15 speakers, 128 participants and 23 company representatives) from 15 countries (Austria, Belgium, China, Czech Republic, France, Germany, Italy, Lithuania, Poland, Russia, Slovakia, Spain, Sweden, Switzerland, United Kingdom).

The school is traditionally designed in such a way that the lectures at the school are given only by invited speakers, eminent scientists in their fields. Each speaker gave two lectures of 50 minutes each, with the first introductory part followed by more advanced topics scheduled usually half a day or a day later to provide time for the audience to “digest” the information and/or to provide feedback to the speaker.

The participants presented their research, mostly being a part of their PhD study, during the poster session with 60 posters.

The best posters were awarded prizes as follows:

1. Krishna Chytanya Chinnam (Strathclyde University, UK): Optimization of the gate dielectric for low voltage organic thin-films transistors,
2. P. Klenovský, P. Klapetek, M. Valtr (Masaryk University Brno, Czech Metrology Institute Brno): Near field scanning ellipsometry - polarization resolved NSOM
3. L. Štolcová, J. Proška, F. Novotný, M. Procházka, I. Richter (Czech Technical University in Prague): Fabrication of SERS substrates using self-assembled nanostructures,

The company evening took place on Wednesday June 1<sup>st</sup> as a small exhibition where 27 companies presented their products or profiles. In addition, three companies brought their microscopes for demonstrations in the course of the school, allowing the participants to get hands-on experience (MT-M with Bruker AFM microscopes, RMI with NT-MDT AFM and WITec with an AFM/Raman setup for microspectroscopy).

The panel discussion took place on Thursday evening, moderated by Prof. L. Montelius, (Lund University) focussing on scientific social responsibility or, in other words, how to explain why I am doing what I am doing in research (and to whom I want to explain that).

A CD-ROM with proceedings of the school is now being prepared, containing the presentations from the school, posters, list of contacts to the lecturers, participants and participating industry etc. A reduced version of the proceedings will also be available at the summer school web page ([www.fzu.cz/~iss](http://www.fzu.cz/~iss)).

## School topics

The school was kicked off by a lecture by Walter Riess (IBM Zurich) who illustrated how the nanotechnology is becoming the everyday reality in electronic devices. He illustrated the broad range of materials which are now being used, spanning nearly the full Mendeleev table. He also pointed out the energy requirements (information technology currently consumes about 2 % of the global electricity production, but this share is bound to increase and the energy requirements of the expected Exaflop computers are staggering).

Thus the topic of energy and especially the role of nanotechnology for renewable energy resources was strongly present in the school. The topic was introduced by M. Londeborough (Academy of Sciences of the Czech Republic) in a fascinating talk which included demonstrations of energy content in fuels, biomass and food. As a chemist, Michael has focused on how photosynthesis provided us with ample resources of energy on which our current civilization is based - and how fast we use them now.

One of the prominent topics of the school was a section on photovoltaics, started by Ivan Gordon (IMEC, Leuven, Belgium) with a talk on **Crystalline Silicon solar cell research: where nanotechnology meets photovoltaics**, certainly one of the highlights of the school. He was followed by Jens Schneider from a company CSG Solar (Thalheim, Germany), who showed what obstacles need to be overcome to bring the research into reality. His talk was thus aptly titled: **"Reality is a bitch" - from lab to production** (actually a quote of one of the company founding fathers).

The photovoltaic section was rounded up by Markus Schubert (Stuttgart University). We usually invite new speakers for each school in a series and thus the lectures are not repeated but there are notable exceptions. Markus Schubert came again after 12 years and he brought a fascinating sequel to the previous talk on using flexible solar cell array as a retina implant which included a fascinating video of the first patients with a vision restored after complete blindness.

Nanoscience requires proper tools for manipulating and measuring the matter down to atomic precision. This topic was represented by Franz Giessibl (Regensburg University) who pioneered the atomically resolved atomic force microscopy. Klaus Wandelt (Universities of Bonn and Krakow) gave a persuasive presentation how atomically resolved studies can be performed even in liquid environments, contradicting a commonly held opinion that ultra high vacuum is required to keep surfaces clean enough. Very advanced results were presented by Hongjun Gao from Beijing Institute of Physics, illustrating the enormous progress of Chinese research. Use of scanning probe microscopy for a wide range of electronic measurements was shown by Christian Teichert (Montan University Leoben). A unique lecture titled **Exploring Nano: what can we learn/expect from theoretical studies?** by Pavel Jelínek (Institute of Physics, Prague) aimed at bridging the gap between experiments and theoretical results.

AFM is now also basis of nanomechanical research which allows X-ray diffraction study of individual nanostructures mechanically stressed by the AFM tip, as presented by Thomas Cornelius (ESRF Grenoble).

Javier Aizpurua (CSIC, San Sebastian, Spain) gave the audience an enthusiastic insight into the subject of resonant optical antennas being a part of the immerging field of plasmonics.

A short dive into nanomagnetism and spin electronics was presented by Olivier Fruchart (Institute Neel, Grenoble), seconded by Markus Etzkorn (Max Planck Institute Stuttgart). Finally, an interface between the nanostructures, especially nanowires, and biological research was the subject of the final talk by Lars Montelius (Lund University).

### **Presence of industry at the school**

The school relied also on support of the companies without whom we would not be able to keep a very low school registration fee (~220 Euro), which is necessary to make the school affordable to students. Bringing the students together with the company representatives serves one more important purpose of establishing future contacts or perhaps careers.

The traditional industry evening took part on Wednesday with participation of the following companies:

HVM Plasma	<a href="http://www.hvm.cz/">http://www.hvm.cz/</a>
SHM	<a href="http://www.shm-cz.cz/en">http://www.shm-cz.cz/en</a>
Measurement Technic Moravia	<a href="http://www.mt-m.eu/">http://www.mt-m.eu/</a>
RMI	<a href="http://www.rmi.cz">http://www.rmi.cz</a>
H-TEST	<a href="http://www.htest.cz/">http://www.htest.cz/</a>
WITec	<a href="http://www.witec.de/">http://www.witec.de/</a>
TESCAN	<a href="http://www.tescan.com/">http://www.tescan.com/</a>
FEI Czech Republic	<a href="http://www.fei.com/">http://www.fei.com/</a>
SPECS	<a href="http://www.specs.com/">http://www.specs.com/</a>
Omicron NanoTechnology	<a href="http://www.omicron.de/">http://www.omicron.de/</a>
Uni-Export Instruments	<a href="http://www.uniexport.co.cz/">http://www.uniexport.co.cz/</a>
Pfeiffer Vacuum Austria	<a href="http://www.pfeiffer-vacuum.com/">http://www.pfeiffer-vacuum.com/</a>
Oerlikon Solar	<a href="http://www.oerlikon.com/solar/">http://www.oerlikon.com/solar/</a>
Optaglio	<a href="http://www.optaglio.cz/">http://www.optaglio.cz/</a>
Renishaw	<a href="http://www.renishaw.com/">http://www.renishaw.com/</a>
CS Clean Systems	<a href="http://www.csleansystems.com/">http://www.csleansystems.com/</a>
ON Semiconductor	<a href="https://www.onsemi.com/">https://www.onsemi.com/</a>
Optik Instruments	<a href="http://www.brukeroptics.cz/">http://www.brukeroptics.cz/</a>
Specion	<a href="http://www.specion.biz/">http://www.specion.biz/</a>
Chromspec	<a href="http://www.chromspec.cz/">http://www.chromspec.cz/</a>
TESTE	<a href="http://www.teste.cz/">http://www.teste.cz/</a>
JEOL	<a href="http://www.jeol.com/">http://www.jeol.com/</a>
Vakuum Praha	<a href="http://www.vakuum.cz/">http://www.vakuum.cz/</a>

In Prague on 24<sup>th</sup> June 2011

Antonín Fejfar (Institute of Physics, Academy of Sciences of the Czech Republic, Prague)  
and  
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On behalf of the school organizers:

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