



OPEN ACCESS GOVERNMENT

CLICK the TAB
to go to the section you want

ISSN 2055-7612 • May 2017

HEALTH &
SOCIAL CARE

SCIENCE &
RESEARCH

FINLAND FOCUS

EDUCATION,
TRAINING & HR

CULTURE &
HERITAGE

FINANCE

THE BUILT
ENVIRONMENT

ENVIRONMENT

ENERGY

TRANSPORT

CYBERSECURITY

ICT



92

SPACE STRATEGY PUSHES THE BOUNDARIES OF KNOWLEDGE IN EUROPE

MAROŠ ŠEFČOVIČ, VICE PRESIDENT OF THE
EUROPEAN COMMISSION EXPLAINS HOW THE
SPACE SECTOR MAKES LIVES BETTER, SAFER
AND HEALTHIER

Image: © O/HB

IN THIS ISSUE

62

Dr Chris Weis of the National Institutes of Health, talks about the dangers of long-term asbestos exposure

150

Riku Huttunen, Ministry of Economic Affairs & Employment, shares Finland's ambition to achieve carbon neutrality

276

Julian King, EU Commissioner says Tackling cybercrime must be a consideration for everyone

Supported by



UNIVERSITÀ
DEGLI STUDI
DI MILANO



The **Balgrist**



Center for Eldercare & Rehabilitation Technology
University of Missouri



Electronics and photonics: Key enabling technologies

Slovak University of Technology's Professor Daniel Donoval highlights the scope as well as the influence of electronics and photonics in the modern world

Electronics and photonics have been identified as the key enabling technologies that have a tremendous impact on innovation in our life. Today there is no industrial or societal branch which is not armed by micro/nano-electronics and/or photonics structures, devices and smart systems. They provide various equipment, technology lines, automotive and transportation networks, with significant smart abilities enabling them to control the functional capability. They are an integral part of systems for energy harvesting, to supply autonomous communications platforms and systems, as well as systems for monitoring the quality of the environment.

The Slovak University of Technology in Bratislava (STUBA), is the oldest technical university in Slovakia. It is attended by around 15,000 students and belongs to the leading university in micro/nano-electronics and photonics education and R&D activities in the new EU member states. The Institute of Electronics and Photonics (IEP), Faculty of Electrical Engineering and Information Technology of STUBA is very active in advanced key semiconductor technologies. Its activities are ensured by complex involvement of new innovative solutions based on smart electronic, sensory and photonic systems for a bigger competitiveness, as well as for a better quality of life in a field of health, wellness, and the environment. Corresponding long-term effort brings

a lot of knowledge and experience which are immediately implemented into related curricula in electronics, particularly in master's and PhD studies, which are unique in Slovakia and serve as a platform for the international exchange of students within programmes such as ERASMUS.

Micro/nano-electronics at STUBA

The technology line for preparation of micro/nano-electronics structures is very costly, therefore we concentrate more on the measurement, characterisation and parameters evaluation, as well as on device design including 2/3D electro thermal modelling and simulation.

The IEP is mostly oriented on design, characterisation and parameters extraction of selected semiconductor structures and devices supported by 2/3D electro thermal modelling and simulation. Such simulation is important particularly for power devices where the generated heat is significant and its distribution through the chip may strongly influence device properties. We have developed numerical tools for fast electro thermal simulation with calibrated parameters of the device models for Si and GaN based structures. The results of modelling and simulation are useful not only for design and prediction of the properties of new structures, devices and systems, but also for the identification of origin and locations of defect regions. The simulated

results are compared with experimental electrical characteristics, which compared with optical and analytical characteristics provide complex view and identification of defects and critical regions on the analysed samples.

IC design uses the EURO PRACTICE services, targeted the ultra-low energy IC design on a chip, IC design for energy harvesting as well as full custom (ASIC) and semi-custom (FPGA) circuit particularly for smart systems. Chip testing, measurement, characterisation and evaluation are the integral part of our work in IC design.

In sensory IEP is involved in new types of sensors using either the metal oxides for gas sensors or sensor arrays, or sensors based on diamond and graphene nanostructures. The main focus in metal-oxide sensors is given to design, preparation and process optimisation by special surface treatment with sensors on a miniaturised heat platform and integrated read-out electronics. The results are then used in international collaboration on solutions for research grants and/or as the innovations of industrial partners, implementing them as the gas sensor arrays for measurement as a concentration of carbon like gases.

Organic electronics.

Problems of an ageing society is not only the issue of decreasing working populations, it is also the need to support the overall level of healthcare.

Organic electronics have gained tremendous research interest for applications not only in electronic devices such as organic light-emitting diodes (OLEDs), or organic solar cells, but also in the growing field of wearable sensors. Organic electronics provides flexible, low-cost, biocompatible, and roll-to-roll mass production that makes it attractive for manufacturers of wearable sensors.

Besides this fundamental research of organic materials, thin film fabrication technologies and the optoelectronic device properties, the research is also focused on sensor applications. Measuring electrocardiographic (ECG) and electromyography (EMG) bio signals, skin moisture monitoring, heart rate variability (HRV) monitoring, respirometry, etc. on a daily basis can be essential for tracking the health of patients, professional athletes, fitness trainees and professionals, and so forth.

Photonics

Photonics has been identified as a key technology with far reaching influences in communications, transportation, medicine, manufacturing, construction, computing, and defence. Photonics research at IEP has long-term experiences in optoelectronics devices design, processing and characterisation of semiconductor PIN photodiodes, LEDs, OLEDs and lasers. Present research is oriented around obtaining a new knowledge in the development of micro/nano-structures up to nanowires (1D) and nanoparticles (0D) for realisation of new optoelectronic and photonic devices based on their unique properties. The investigated structures are fabricated at IEP and within partner institutions, cooperation is based on inorganic Si-SiO₂-SiON, III-V, II-VI semiconductors, mostly GaAs, GaN, ZnO and their alloys, as well as new organic semiconductors. In

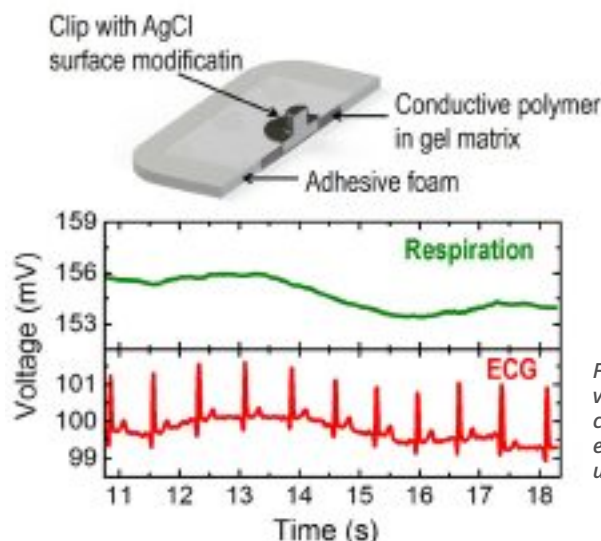


Figure 1: Simplified cross-section view of novel ECG electrode with conductive polymer gel and example of biosignals recorded using this organic electrode

the terms of recent research activities, a universal nanowire platform based on nanowires completely filled with an optically active shell layer is solved for interdisciplinary applications. Structural, electrical and optical properties of prepared micro and nanostructures are studied in the terms of heterojunction analysis, technology process optimisation and photonic crystals (PhC) of different modifications on surface or in the devices. These are applicable in all LED, OLED, photodetectors, solar cells, silicon nano photonics, and hybrid organic-inorganic photonic integrated circuits, with the orientation on enhancement of total device and system efficiency.

Industrial and International collaboration

The well-equipped laboratories, expertise and enthusiasm of institute staff ensure a successful project solution. The 10 experienced professors are supported by about 25 post-docs and PhD students. Active participation in international research projects in frameworks and ECSEL JU projects (about 10 projects), as well as about 15 national projects attract and stabilise young people. Dissemination of obtained results is ensured by their publication in scientific journals and conference proceedings. Collaboration

with companies, particularly SME, organisation of conferences, workshops and transfer of innovation technologies is another means of dissemination activities.

Based on the presented technologies and results, it is clear that IEP STUBA belongs to the leading European institutions and contributes to further development, supporting the leading role of Europe in the mentioned key enabling technologies.

Acknowledgement

The work was supported by the ENIAC JU and ECSEL JU projects e-Ramp, PowerBase, Osiris, Safesens, IoSense as well as national projects APVW -14-0739 and VEGA 0491-15.



Prof. Daniel Donoval

Faculty of Electrical Engineering and Information Technology
Slovak University of Technology
Tel: +421 903 408 703
daniel.donoval@stuba.sk
http://www.fe.i.stuba.sk/