Marián Varga

Institute of Electrical Engineering SAS

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Project duration 1.8.2024-31.7.2029

" The IMPULZ programme represents a unique opportunity that will allow me to advance in cutting-edge research areas and strengthen collaboration between Slovak and international institutions with the aim of securing joint European grants."

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BIOGRAPHY

Marián Varga received his Ph.D. from the Slovak University of Technology, Faculty of Electrical Engineering and Information Technology, Bratislava, in 2013. In 2011, he joined the Diamond Materials Group led by Prof. Alexander Kromka at the Institute of Physics, Czech Academy of Sciences in Prague, first as a PhD student and later as a postdoctoral researcher. His research primarily focuses on the chemical vapor deposition (CVD) of carbon-based materials and composites, particularly thin polycrystalline diamond films, in both intrinsic and doped forms. His work extends to post-growth modifications, including nanostructuring, etching, surface chemical functionalization, and the characterization of opto-electronic properties in the resulting (hetero)structures. His contributions to the field are documented in over 75 scientific publications (>1350 citations, H-index 18), a book chapter, and a utility model. Since August 2020, he has been working as a researcher at the Institute of Electrical Engineering of the Slovak Academy of Science (IEE SAS) as a grant holder of the MoRePro Programme of the SAS focused on a unique combination of 2D and 3D materials represented by transition metal dichalcogenides (TMD) and diamond. In 2022, he applied for an ERC Consolidator Grant and received a 'B', providing a strong foundation for future ERC applications. In 2024, he was awarded the prestigious IMPULZ grant, enabling him to continue pioneering new research topics at IEE SAS, where he is establishing a new research group and strengthening international collaborations.

Cost-effective Ga2O3-diamond heterojunction photodetectors for solar-blind UV imaging

One of the most significant challenges in the recent years, related to the development of new electronic devices with a potential for major improvements of the current state in a vast variety of human activities can be found in the field of solar-blind (SB) ultraviolet (UV) photodetectors (PDs). Novel UV PDs, especially those for deep-UV (DUV) optoelectronics (wavelengths shorter than 280 nm) are needed. These cannot typically be manufactured from conventional materials (bandgap below ~3 eV), leading to development of ultrawide bandgap (UWBG) semiconductors (such as AlxGa1−xN, hBN, Ga2O3, and diamond) and their utilisation for SB UV PDs. Gallium oxide (Ga2O3), a naturally n-type semiconductor, represents a suitable UWBG material, showing a very good potential and capability to significantly improve the current state-of-the-art electronic devices. Furthermore, synthetic diamond has gained a strong reputation to be an exceptionally versatile material due to its attractive physical and chemical properties and availability of facile preparation of films with p-type conduction. On the other hand, it is very difficult to prepare p-type Ga2O3 and n-type diamond. The aim of this project is development and detailed characterisation of new high-performance DUV SB PDs with p-n or p-i-n structure, comprising n- and i-type Ga2O3 and p-type diamond. Such heterostructure devices represent a favourable solution combining the best of the two UWBG worlds. Experimental work will be strongly supported by the computational modelling of the used heterostructure and its properties. It will serve as important feedback for growth technology and device fabrication, critically pointing out the fundamental physical and electronic aspects of designed heterostructures where the current experimental data are insufficient to provide a complete theoretical understanding and optimum device design. Continuous optimisation of the heterostructure properties via tailored doping and interconnection of materials will enable us to design and fabricate a unique functional solar-blind UV photodetector array with enhanced detector performances. It is also expected that achieved improvements, cost-effective and optimised size-scalable technology will be of interest to the UV detector research community and related industrial sector.

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PUBLICATIONS

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