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# Direct optical lithography and scanning laser processing of materials for advanced optoelectronic applications

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A large number of modern micro- and optoelectronic devices and advanced sensor technologies does not require fabrication tools with ultimate resolution like a currently commercialized 2 nm technology of silicon-based chips. These are, for example, stand-alone microsensors or MEMS, for which a low price is preferred, while there is no need for close packing or miniaturization below μm-scale. Some applications pose even fundamental limitations on the device dimensions, for instance IR or THz sensing elements (or antennas) cannot be smaller than the targeted wavelength (which is in μm- or tens-of-μm- scale).
This situation stimulates the development of the methods and technologies for a more efficient (i) formation and characterisation of various micro-systems and (ii) controlled local modification of the material's properties at the μm- and sub-μm- scale.
Advancement in CW and pulsed solid-state and semiconductors laser technologies enabled affordable high-quality lasers over the whole visible and near infrared spectrum. Owning to the small size and weight, then can be integrated into computer-controlled scanning system for a very fast patterning and processing of materials.
Due to these instrumental developments, the field of direct optical lithography started to grow. The use of traditional photomasks is not a sufficiently flexible method of creating device structures at the stage of their development and research, since to make even minor changes to the architecture of the device, it is necessary to produce a completely new set of masks. That is why non-contact photolithography based on laser sources are gaining more and more popularity in the research sector as a method of structuring materials and modifying their physical properties, which could be a new qualitative breakthrough for the entire industry in the nearest future.
Maskless photolithography is a convenient tool that allows us to create not only surface structures and mask designs, but also 3D optical structures. It has been successfully applied to structuring thin quantum dot films, production of contact electrodes for 2D materials with flake sizes of 1-2 μm for field-effect transistors, receiving antennas of THz radiation receivers, enhancement of IR absorption by detectors, and many other applications.
The development of the maskless lithography in Ukraine for research and education purposes is initiated in the framework of the research project "Creation of a State Key Laboratory «Centre of critical optoelectronic micro-/nano-technologies and expertise»"funded by the National Research Foundation of Ukraine at the V. Lashkaryov Institute of Semiconductor Physics of the National Academy of Sciences of Ukraine.

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