ULTRAFAST LASER MICRO- AND NANO- PROCESSING (ULMNP) Group

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ABSTRACT

The unique characteristics of ultrashort pulsed lasers, emitting light pulses shorter than a few tens of picoseconds, have paved the way for new exciting emerging avenues for innovation and exploitation in the photonics industry.

In the Ultrafast Laser Micro- and Nano- processing group (ULMNP) of IESL (https://www.iesl.forth.gr/en/research/ULNMP-Group ; http://stratakislab.iesl.forth.gr/) research is focused on the development of novel ultrafast pulsed laser processing schemes for controlled biomimetic structuring at micro- and nano- scales of a variety of materials, including biopolymers. By applying ultrafast laser pulses novel surface structures with sub-micron sized features are produced while the physical properties of semiconductor, dielectric and metallic surfaces are significantly modified. The biomimetic surfaces developed exhibit controlled dual-scale morphology that mimics the hierarchical structuring of natural surfaces with exciting properties (i.e. the Lotus leaf, the Shark Skin, the Butterfly wings). As a result, the biomimetic morphology attained gives rise to notable multifunctional properties including water repellence, self-cleaning, antibacterial, anti-sticking, anti-fogging, anti-reflection and combination of those (b) smart, i.e show the ability to change their functionality in response to different external stimuli. The ability to tailor the morphology and chemistry is an important advantage for the use of the biomimetic structures as models to study the dependence of growth, division and differentiation of cells on the surface energy of the culture substrate, as well as 3D scaffolds for tissue regeneration. At the same time, novel ultrafast non-linear imaging tools are employed to characterize the biological processes taking place during the development of tissue into 3D scaffolds. At the same time, ULMNP focuses on the ultrafast laser-based development of various types of nanomaterials, nanolayers and processes applied in photovoltaic, gas sensing and energy storage applications. The exploitation of ultrashort pulses for the doping, functionalization, spectroscopic diagnosis and quality control of graphene and other 2D materials is additionally explored, placing emphasis on the understanding of the fundamental physical properties of such materials.