Laser-induced processing of solids for the development of functional bio-inspired surfaces.

E.Skoulas [1,2*], A.Papadopoulos[1,2], A.Mimidis [1,2], S.Kiokekli[1,2], C.Lanara[1,2], A.Karagiannaki[1,2], M.Triantafylou[1,2], E.Petrakakis [1,2], M.C.Velli [1,3], I.Sakellari [1], F.Fraggelakis [1], S.Maragkaki [1], G.D.Tsibidis [1*] and E.Stratakis [1,2*]

[1] *Institute of Electronic Structure and Laser (IESL), Foundation for Research and Technology (FORTH), N. Plastira 100, Vassilika Vouton, 70013, Heraklion, Crete, Greece*
[2] *Materials Science and Technology Department, University of Crete, 71003 Heraklion, Greece*
[3] *Physics Department, University of Crete, 71003 Heraklion, Greece*

Presenting *author:* E.Skoulas , *email*:skoulasv@iesl.forth.gr
* Corresponding author:,email: skoulasv@iesl.forth.gr, tsibidis@iesl.forth.gr; stratak@iesl.forth.gr

ABSTRACT

Nature has always provided a plethora of functional surfaces exhibiting unique, complex hierarchical morphologies with dimensions of features ranging from the macroscale to the nanoscale. Such morphologies are always behind the superior properties exhibited by the natural surfaces, including extreme wetting, floatation, adhesion, friction and mechanical strength.

In principle, femtosecond laser induced surface structuring has been demonstrated to produce numerous biomimetic structures for a range of applications, including microfluidics, tribology, tissue engineering and advanced optics. In this poster, we present a summary of the research activities by the ULMNP group towards producing biomimetic self-assembled structures of variable shape and periodicity (i.e. ripples, grooves, spikes, more complex structures, etc.) on various types of materials. The primary objectives of the research work aims to (i) enhance our knowledge of the physical mechanisms that are related to the development of the aforementioned complex structures through a novel multi-scale theoretical model that describes fundamental physical processes after laser irradiation of the solid +machine-learning-based approaches for predictive modelling, (ii) allow a systematic investigation of the laser conditions (i.e. fluence, wavelength, irradiation dosage, pulse duration, polarisation) that lead to structures with application-based and preferential opto-wetting features (i.e. antireflection and extreme wetting properties) and tribological properties, (iii) provide an analytical exploration of the opto-wetting properties and correlate these features with the morphological structural characteristics.

Our results indicate that the fs-based processing of solids constitutes an efficient and robust technique towards the production of highly-ordered, multi-directional, and complex biomimetic structures. Furthermore, the fabrication of a plethora of complex structures by varying the laser beam parameters brings about a new concept in laser structuring and it can be considered as an emerging laser-based fabrication technique.

REFERENCES

[1] Papadopoulos A., Skoulas E., Mimidis A., Perrakis G., Kenanakis G., Tsibidis G.D.,, and Stratakis E., ‘Biomimetic omnidirectional anti-reflective glass via ultrafast laser nanostructuring’, **Advanced Materials 31**, (32), 1901123 (2019).

[2] Petrakakis E., Tsibidis G.D., and Stratakis E., ‘Modelling of the ultrafast dynamics and surface plasmon properties of silicon upon irradiation with mid-IR femtosecond laser pulses’ **Physical Review B 99**, 195201 (2019).

[3] E. Skoulas, A. Manousaki, C. Fotakis, and E. Stratakis, **Nature-Scientific Reports 7**, 45114 (2017).