Laser-induced surface structuring: an effective approach for surface functionalization

Jijil JJ Nivas [1,2,3]

[1] *Dipartimento di Fisica "Ettore Pancini", Università degli Studi di Napoli Federico II, Complesso Universitario di Monte S. Angelo, Via Cintia, I-80126 Napoli, Italy*
[2] *CNR-SPIN, UOS Napoli, Complesso Universitario di Monte S. Angelo, Via Cintia, I-80126 Napoli, Italy*
[3] *Istituto Nazionale di Fisica Nucleare, Sezione di Napoli, Complesso Universitario di Monte S. Angelo, Via Cintia, I-80126 Napoli, Italy*

Femtosecond (fs) laser micromachining of solid surfaces offers a versatile approach for directly writing surface features with a wide range of sizes, from subwavelength scales to millimeters. Unlike traditional fabrication processes, fs laser micromachining allows for the creation of highly stable surfaces with unique properties. The resulting surface microstructures are influenced by several experimental parameters, including the laser wavelength (λ), polarization, pulse energy, number of pulses (N), repetition rate, and scan velocity. These parameters determine the formation of various surface textures, including quasi-regular laser-induced periodic surface structures (LIPSS) such as subwavelength ripples, nano-cones, spikes, holes, columns, and more. Additionally, random structures such as nanoscale cavities, rims, protrusions, and the distribution or aggregation of nanoparticles can also be achieved. This capability opens up numerous potential applications in areas such as optics, biomaterials, microfluidics, and more. Surface functionalization achieved through laser-induced structuring offers several advantages. Firstly, it allows for the precise control and manipulation of surface properties, such as surface roughness, hydrophobicity/hydrophilicity, friction, and optical properties. This enables the creation of surfaces with desired functionalities, such as self-cleaning, anti-reflective, or anti-bacterial properties. Secondly, laser-induced surface structuring offers a non-contact and non-chemical method for surface modification, reducing the risk of contamination or damage to the material. The process is highly scalable and can be applied to a wide range of materials, including metals, polymers, ceramics, and composites. Lastly, laser-induced surface structuring provides a fast and efficient way to achieve surface functionalization. The process can be performed in a single step, eliminating the need for complex and time-consuming multi-step fabrication processes.

In the seminar, the principles of surface structuring using fs laser pulses will be discussed, highlighting the vast potential and versatility of this technique. Furthermore, various practical applications based on surface functionalization of different materials will be explored, demonstrating the wide range of possibilities offered by fs laser micromachining in modifying and enhancing surface properties.