FLAMN-25

FUNDAMENTALS OF LASER-ASSISTED MICRO- AND NANOTECHNOLOGIES

FLAMN – 25 LIST OF TOPICS

Laser-assisted surface functionalization & related phenomena

- The physical fundamentals of laser microstructuring of solid surfaces.
- Laser structuring of hard and soft materials.
- Main functional surfaces in medicine and energy industry incl. solar cell, and other industrial fields.
- Control of various properties of material surfaces using lasers: optical, chemical, electrical, mechanical, wetting, biocompatibility, antimicrobial, and more.
- Measurement of surface geometry and physical-chemical properties.
- Laser smoothing of a surface.
- Features of laser-induced oxidation and coloring.
- Ultrashort laser pulsed micro- and nanotechnology.
- Ultrafast laser modification of different materials composition.
- Laser processing of thin films.

Fundamentals of light-matter interaction

- Mechanisms of laser heating, phase and structural transitions in solids.
- Physical fundamentals of laser-based microtechnologies, including modeling and quantitative analysis.
- Nonlinear optical effects in matter under intense laser irradiation.
- Physical mechanisms of laser damage of optical materials and elements.
- Interaction of ultrashort laser pulses with matter.
- Laser-matter interactions in near-field.
- Mechanisms and regularities of laser ablation.
- Instabilities and self-organizing processes under laser exposure.
- Ultrafast laser heating, melting, and ablation.
- Photo-stimulated crystallization and amorphization.
- Adsorption and orientation of organic molecules on surfaces.
- Advanced applications of phase change phenomena in optical materials and memory alloys.
- Dynamics of plasmon excitations in nanostructures on the femtosecond time scale.
- Fundamental principles of femtosecond laser technology.
- Laser-induced reversible structural transformations in solids.
- Fundamentals of photo- and thermochemical modifications of material composition and properties.

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Biomedical laser technologies

- Mechanisms of laser-tissue interaction.
- Surgical and other applications of lasers.
- Laser and optical diagnostics.
- Optical clearing and light propagation in cells and biological tissues.
- Laser-tissue microprocessing.
- Light-assisted drug delivery.
- Photodynamic therapy.
- Optical coherence tomography and its application.
- Action of lasers on cartilage tissues.
- Biotissue regeneration induced by laser.
- Selective laser photothermolysis and its applications.
- Sub-ablative laser processing of biological tissues.
- Adaptive lasers for biological tissue processing.
- Ultrafast lasers for biomedical applications.
- Terahertz radiation interactions with cells and tissues.
- Functionalization of implants using lasers.
- Bactericidal structured surfaces.
- Surface functionalization of medical devices and tools using lasers.
- Laser bio-printing.
- Biomedical materials.
- Laser systems and technologies for the medical industry.

Laser materials science

- Application of lasers in material science.
- Laser synthesis, patterning and modification of nanoscale/nano-structured materials.
- Laser spectroscopy and characterization.
- Materials for photo-, electro- catalytic, photoelectrocatalytic applications.
- Laser printing/writing of functional devices.

Laser-induced periodic surface structures

- The creation of laser-induced periodic surface structures on different materials.
- Thermochemical laser-induced periodic surface structures.
- Advancements in laser processing for surface engineering (including direct laser interference patterning).
- Impact of laser parameters on LIPSS morphology.
- Characterization techniques for LIPSS.
- Self-organization processes and patterns under laser irradiation.
- Optical properties of laser-induced periodic nanostructures.

Nanophotonic phenomena & materials

- Nanolasers and spasers.
- Nanostructures in photodetectors and solar cells.
- Nanostructured materials for non-electrical conversion of optical energy, such as water boiling and chemical reactions.
- Advanced computational methods for the modeling of photophysical processes in nanostructures.
- Charge and energy transport in nanoscale systems.
- Nonlinear optical processes in nanostructured materials.
- Enhancement of exciton-plasmon interactions in hybrid nanostructures under strong laser fields.

Laser technologies for nanoscale science and engineering

- The physics behind laser methods in nanotechnology.
- Laser fabrication, modification, and conditioning of nanostructures.
- Synthesis/formation of nanoparticles using lasers in different environments.
- Laser-driven self-assembly of nanoparticles.
- Transfer of nano- and microparticles using lasers.
- 3D laser nanoprinting.
- Space and time-resolved characterization of nanostructures using lasers.
- Processing of advanced optical materials using lasers.

Nano- and molecular systems for optical and biomedical applications

- Laser fabrication of nano- and molecular systems.
- Functionalized nanostructured materials for medical treatment.
- Optical chemo- and bio-sensors based on nanocomposites.
- Plasmon-enabled near-infrared molecular sensing.
- Laser-assisted bio-nano photonics.
- Chiral nanostructures for biosensing.
- Laser-based approaches in bioimaging
- Nanoparticles for anti-bacterial purposes.

Ultrafast laser-based microstructuring and modification of transparent materials

- Ultrafast laser-based microstructuring of transparent dielectrics and semiconducturs.
- Laser-induced microplasma for structuring of transparent materials.
- Interaction of ultrashort laser pulses with transparent materials.
- Ultrafast laser techniques for 3D microstructuring of glass.
- Fabrication of microfluidic devices using ultrafast laser processing.
- Nonlinear optical effects during ultrafast laser microstructuring of transparent materials.
- Laser-induced changes in refractive Index of transparent substrates.
- Design and ultrafast laser fabrication of waveguides for photonic applications.
- Ultrafast laser-induced recording of Bragg gratings.

Industrial laser technologies: automatization & application of ML

- Surface processing technologies for industrial use (texturing, cleaning, annealing, modification, etc.)
- Advances in classical laser technologies: drilling, cutting, welding, thermal treatment etc.
- Laser marking and security labeling.
- Laser additive manufacturing: novel applications, characterization, and equipment.
- Precision laser microshaping techniques such as cutting and drilling.
- Surface cleaning and removal of rust and mill scale using lasers.
- Laser soldering and microwelding.
- The application of machine learning to improve laser-based industrial technologies.
- Automatization and robotics systems for laser processing.
- Laser technologies for microelectronics including photolithography.

Light sources & optical solutions for laser technologies

- Improved laser sources, optical systems, beam delivery, beam shaping, and wavefront control for micro-machining.
- Advances in semiconductor lasers.
- Advances in fiber including gas fiber lasers.
- Fiber and integrated optical solutions for photonic devices.
- Applications of lasers in fiber and integrated optics.
- Development of single-frequency laser sources.
- Optical solutions for beam shaping.
- Optical and phase elements for light structuring.
- Fabrication of photonics components using laser-based techniques.
- Laser and optical devices, and laser systems for micromachining.
- In-situ measurement of laser processing characteristics.
- Fabrication of advanced optical components with ultrashort laser pulses.

Special scientific events

Laser and optical-based approaches in Art & Science

- Lasers and optics for artifact cleaning including laser cleaning of stone, metal, wood, paper, parchment, painted surfaces.
- Combined methods of surface characterization for investigation of artworks including Raman/LIF, LA-ICP-MS, SEM & EDS, SIMS, GD-OES & GDMS, etc.
- Non-destructive testing techniques: spectroscopy, IR thermography, speckle interferometry, holography, optical coherence tomography, etc..
- Imaging and testing: terahertz, hyperspectral, and multispectral imaging.
- Portable device development and applications in arts.
- Light-assisted preservation and conservation methods.

Education in lasers/photonics

- Novel educational technologies in photonics and lasers.
- Problem-based and project approaches for education in photonics.
- Laboratory-Based Learning.
- Online education in photonics and lasers.
- AI applications for educational purposes in photonics and lasers.