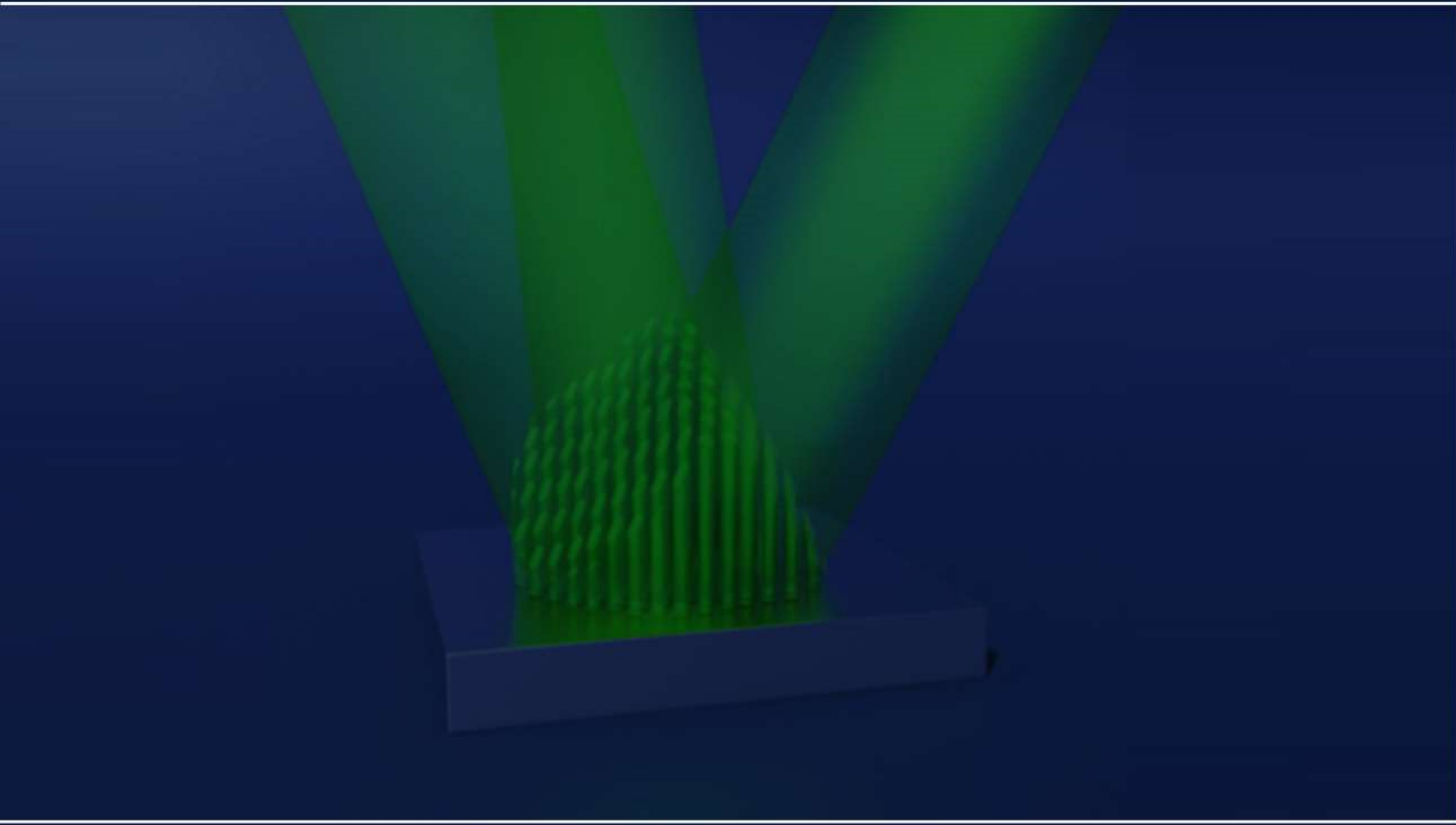


Annual report 2020/2021

Chair of Large Area Laser Based Surface Structuring

Professur für Laserbasierte Methoden der großflächigen Oberflächenstrukturierung

Preface

Dear friends and partners of the LMO Professorship,
Dear readers,

The "*Professur für Laserbasierte Methoden der großflächigen Oberflächenstrukturierung*" (Chair of Large Area Laser Based Surface Structuring) is the result of the successful establishment of the so-called "Open Topic Tenure Track Professorships (OTTP)" Program of the TU Dresden.

After the very successful realization of the OTTP project, the chair was permanently integrated into the structure of the TU Dresden in 2019 and has continued with its tradition in performing high-quality research in the field of laser-based processes with the aim of functionalizing surfaces. Within this framework, we offered two new lecture modules for our students, dealing with the applications of laser methods for the functionalization of surfaces as well as photonic measurement technologies, the last together with Prof. Thomas Arnold.

In addition to the impressive number of publications in peer-reviewed journals in 2020 and 2021, the chair has been awarded with a significant number of national and international prizes. In addition, we have organized the "Laser Precision Microfabrication Symposium 2020", in cooperation with the *Deutsche Gesellschaft für Materialkunde e.V.*. The last was performed as web-conference due to the COVID pandemic situation. However, next year in June 2022 we will have the chance to bring this conference to Dresden, showing our capabilities to the international community on laser precision microfabrication.

Our strong collaboration with the Fraunhofer Institute for Material and Beam Technology (IWS) in Dresden, under the "Center for Advanced Micro-Photonics (CAMP)" allowed us to develop together new solutions for laser systems, processes as well as metrology components.

We would like to take this opportunity to thank our national sponsors as well as the European Union, our partners and customers for their trust and our employees for their trustful and constructive cooperation.

A selection from our numerous research projects is presented in this report. We invite you to gain an insight into our work and wish you an inspiring read!

Prof. Andrés Fabián Lasagni

Contents

1. The chair in numbers

Expenditure from R&D Income

	2020	2021
Raised funding	1.194.619 €	863.665 €

Employees

	2020	2021
Scientific staff	15	14
Technical employees	0	1
Administration	1	1
Student assistants	10	7
Visiting scientists	3	3
Total employees	29	26

Final theses

	2020	2021
Doctoral theses	3	5
Diploma theses	6	9
Student projects	8	7
Project theses	1	0

Publication record

	2020	2021
Peer-reviewed papers	24	25
Proceedings and conference articles	30	25
Participation in conferences (talks and posters)	53	52

2. Organization chart

Prof. Andrés F. Lasagni
Chair keeper

Lisa Becher
Assistance / controlling

Dr. Bogdan Voisiat
Technology development and transfer

Dr. Robert Baumann
Operation manager and process development

Dr. Marcos Soldera
Manager Modelling and project management

Alexander Bock
Laboratory manager

Chair keeper
Prof. Dr. Andrés F. Lasagni

Assistance / controlling
Lisa Becher

Technology development and transfer
Dr. Bogdan Voisiat

Operation manager and process development
Dr. Robert Baumann

Manager Modelling and project management
Dr. Marcos Soldera

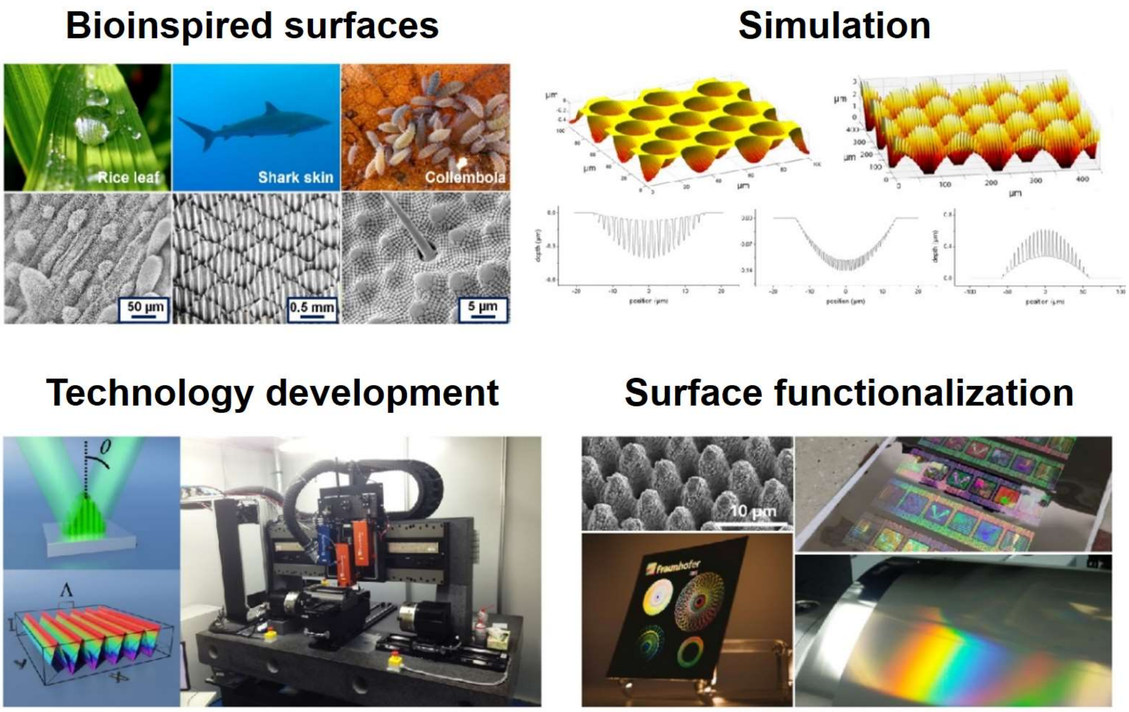
Laboratory manager
Alexander Bock

Post docs / Scientists
Dr. Yangxi Fu
Dr. Lucinda Mulko
Dr. Daniel Sola (Marie Skłodowska-Curie)
Prof. Dr. Bruno Henriques (Alexander von Humboldt)

PhD students
Felix Bouchard
Mikhael El-Khoury
Florian Kuisat
Nikolai Schröder
Lis Zschach
Herman Heffner
Theresa Jähnig
Lars Lorenz
Sascha Teutoburg-Weiss
Stephan Milles
Wei Wang
Sabri Alamri (IWS)
Alfredo Ismael Aguilar Morales (IWS)
Tobias Baselt (IWS)
Jana Gebauer (IWS)
Frederic Schell (IWS)
Tobias Steege (IWS)
Cindy Goopold (IWS)
Tobias Baselt (FH Zwickau)
Christian Bischoff (TOPAG)
Hans-Julius Langeheinecke (BMW)
Björn Michelberger (STZ)
Dmitriy Mikhaylov (BOSCH)
Michael Seiler (Ernst-Abbe-Hochschule Jena)
Tobias Stark (BOSCH)
Vittorio Vercillo (AIRBUS)
Cornelius Demuth (TU Bergakademie Freiberg)

3. Research and teaching activities

Laser technologies offer a number of advantages, such as the precise modification of surfaces without contamination, remote and contact-free processing, a high degree of flexibility and an exactly localized energy input into the material.
The Chair of Large Area Laser Based Surface Structuring (LMO) is engaged in the development of new laser-based methods and technologies for the high-throughput patterning of different materials in order to provide them with a wide variety of structures in the micro- or sub-micrometer range. In this way, surfaces can be provided with new functions or properties.



Focus in research and teaching

- Design of surface functions by structuring relevant technological materials in the micrometer and submicrometer range.
- Development of laser-based methods and technologies for the high-throughput treatment of large surfaces.
- Roll-to-roll processing of polymer foils using UV radiation and hot-embossing methods.
- Structuring of planar and complex substrate surfaces, process and optics development.

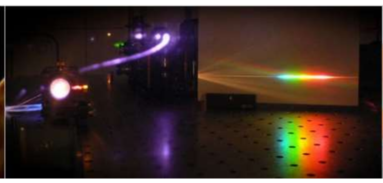
4. Center for Advanced Micro-Photonics (CAMP)

CAMP focuses on laser-based surface modification and patterning processes. The center targets opportunities and challenges in the development of new system, process and measurement solutions. To transfer technologies into the industry, our scientists develop solutions in every step along the entire process chain.

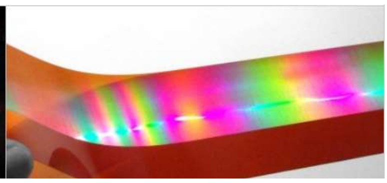
CAMP employs cross-operational approaches ranging from simulation, laser processes and optical measurements to machine learning. The scientists at Fraunhofer IWS and TU Dresden focus on various applications of laser microprocessing and measurement engineering.

The CAMP partners:

Fraunhofer IWS, Business unit Microtechnology



Fraunhofer Application Center for Optical Metrology and Surface Technologies



Chair of Large Area Laser Based Surface Structuring

5. Selected projects

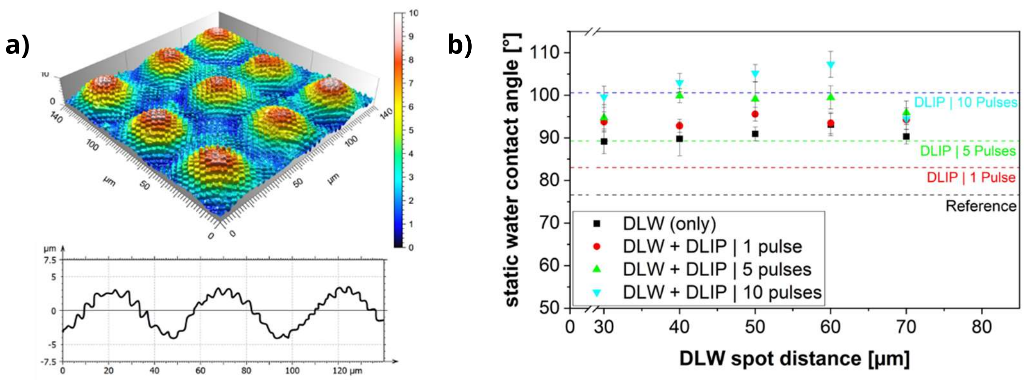
Reinhart-Koselleck project: Processing and wetting behavior of hierarchically microstructured polymer foils

Funding agency: Deutsche Forschungsgemeinschaft
Period: 09/2017 – 06/2024
Project partners: LMO, TU Dresden
Project manager: Dipl.-Ing. Felix Bouchard

The demand for functionalized plastic surfaces inspired by nature is steadily increasing. Even though a variety of processes to create hierarchical textures already exists, cost-efficient and scalable techniques are required for industrial transfer. A possible solution are laser-based methods in combination with replication techniques.

In this project, a strategy for imprinting hierarchical microstructures onto transparent polyethylene terephthalate (PET) films was developed. For this purpose, a stainless steel stamp was processed using Direct Laser Writing (DLW) as well as Direct Laser Interference Patterning (DLIP) and then transferred to 200 µm thick polymer film using a plate-to-plate hot embossing process. Single- and multi-scale structures with structure sizes ranging from 3 µm to 50 µm and depths between 0.1 µm and 10 µm were successfully fabricated.

The transfer quality of the impression process was demonstrated by confocal microscopy and scanning electron microscopy, even for structures with lateral dimensions of less than 100 nm. Final water contact angle measurements showed a direct correlation between the generated surface complexity and the wetting behavior. An increase of the hydrophobic behavior from 77° to up to 105° was demonstrated.



(a) Confocal images and extracted profiles of a hierarchical structured PET film consisting of a DLW structure with diameter 50 µm at a height of 8 µm combined with a 3.1 µm periodic DLIP structure with a height of 1.8 µm. (b) Results of static water contact angle measurements as a function of DLW structure spacing for different texture combinations compared to the unstructured reference surface (black)

Sponsored by:
Deutsche Forschungsgemeinschaft

Deutsche Forschungsgemeinschaft

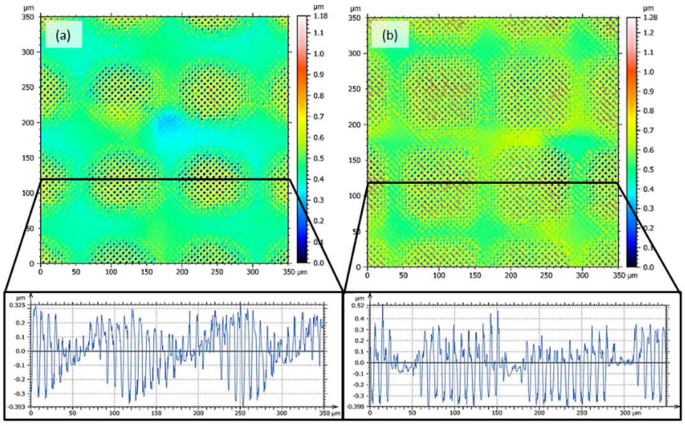
Reinhart-Koselleck project: Improving the pattern homogeneity in Direct Laser Interference Patterning

Funding agency: Deutsche Forschungsgemeinschaft
Period: 09/2017 – 03/2021
Project partners: LMO, TU Dresden
Project manager: M.Sc. Mikhael El-Khoury

Surface topographies with well-defined microstructures and uniform distribution of contact points are required in many applications to obtain an optimized surface functionality. However, the fabrication of uniform periodic microstructures over a large sample area represents a challenge in Direct Laser Interference Patterning (DLIP) technology mainly due to the Gaussian laser beam intensity distribution inherent to most commercial lasers.

In this project, a strategy for generating a square-shaped top-hat intensity distribution in the interference volume of DLIP setup was developed. For this purpose, a diffractive fundamental beam-mode shaper (FBS) element was combined with a DLIP optical configuration. The dot-like interference patterns of 6.5µm spatial period was produced by a symmetrical four-beam DLIP setup with Gaussian and top-hat intensity distributions.

The impact of both laser intensity distributions on process throughput as well as fill-factor is investigated and resulting microstructures height with height error over structured surface is analyzed by confocal microscopy and scanning electron microscopy. Experiments showed that by utilizing top-hat shaped interference patterns it was possible to produce periodic structures that are 44.8 % deeper as well as 60 % more homogeneous at the same throughput, compared to the standard configuration. Moreover, the presented approach allowed the production of microstructures with comparable height and homogeneity with increased throughput of 53%, compared to the Gaussian intensity distribution.



Confocal microscope images of surface topographies produced on stainless steel and corresponding surface profiles using the (a) Gaussian and (b) top-hat beam profiles. Only one laser pulse was used for each spot. The laser fluence was 2.97 J/cm² and the hatch distance was 130 µm.

Sponsored by:
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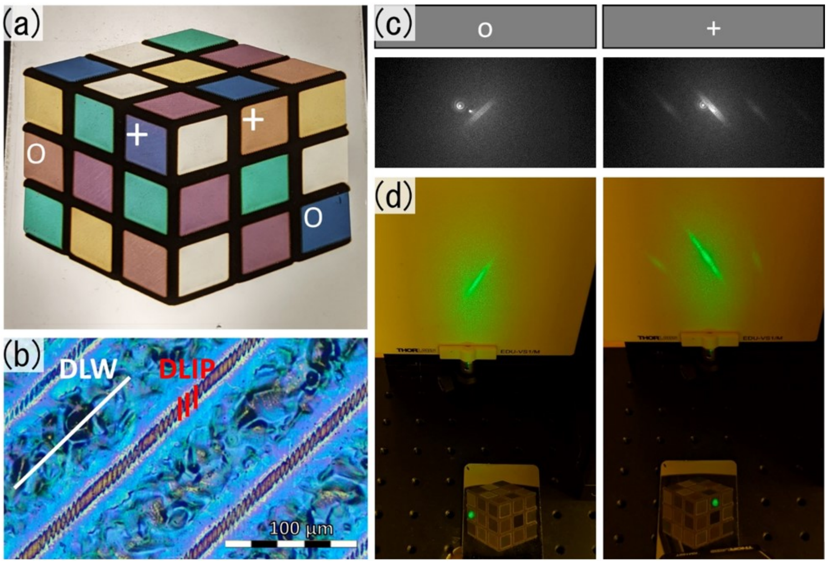
Structural colors with embedded anti-counterfeit features fabricated by laser-based methods

Funding agency: Deutsche Forschungsgemeinschaft
Period: 09/2017 – 03/2021
Project partners: LMO, TU Dresden
Project manager: Dipl.-Ing. Sascha Teutoburg-Weiss, Dr. Marcos Soldera

Deliberately colorizing metal surfaces can serve different purposes, such as decoration and product or brand protection for anti-piracy measures. Usually, surfaces are colorized by depositing a coating with a pigment that is selected to absorb or reflect specific wavelength bands. Despite its broad use, the pigments can degrade over time due to UV exposure, heat, and chemical or mechanical abrasion. In contrast, surfaces with structural colors interact with incoming light through different physical mechanisms, such as thin film interference, diffraction by periodic microstructures, scattering by micro/nanoparticles, or excitation of plasmon resonances or plasmon polaritons. Periodic surface structures with periods of the order of the wavelength of visible light and up to a few microns can act as diffraction gratings for visible radiation. In this research project, stainless steel (EN 1.4301) plates were colorized by growing a thin oxide layer using direct laser writing (DLW) and hidden anti-counterfeit measures are included on their surfaces by direct laser interference patterning (DLIP) processing. The periodic microstructures resulting from the DLIP treatment have a spatial period of 1 µm and act as relief diffraction gratings, featuring a characteristic diffraction pattern. These microstructures are not visible to the human eye but are easily detectable upon shining a coherent beam on the surface.



Photograph of colorized motive with hidden security features (a); optical microscopy image of the DLW-treated lines and DLIP-structure orientation (b); monitoring system images taken from a field with DLIP-structures "+" and from a featureless field with the same color "O" (c). Photographs of diffraction patterns projected on a screen from the corresponding fields labeled as "O" (left) and "+" (right) and upon being illuminated with a laser pointer (d).

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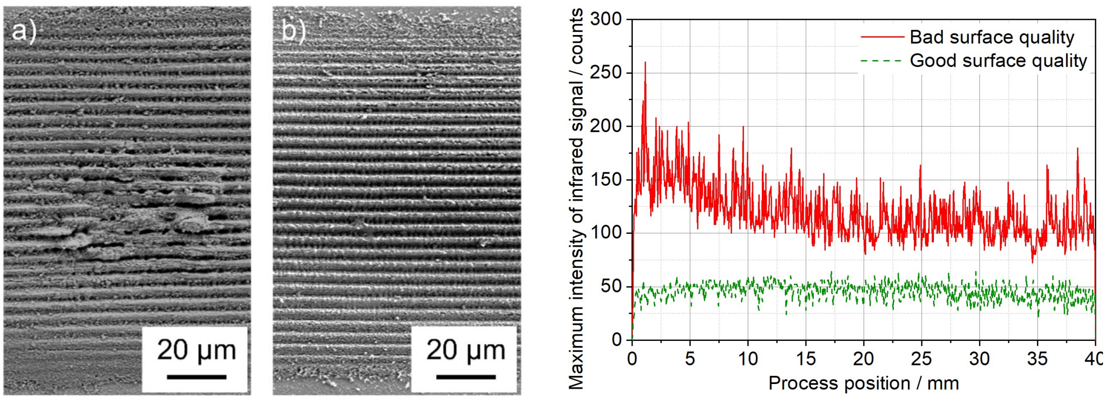
DFG Deutsche Forschungsgemeinschaft

LAMPAS – Project: A new approach for monitoring a DLIP process

Funding agency: European Union – Photonics21
Period: 01/2019 - 12/2021
Project partners: LMO, Trumpf, Lasea, NIT, NextScan, Bosch, BSH, EPIC
Project managers: Dipl.-Ing. Nikolai Schröder

Monitoring methods during laser processes help to improve the process efficiency by optimizing reproducibility as well as increasing the quality of the produced parts. Furthermore, they allow a better understanding of these processes, and the recorded information can be used to developed loop-control algorithms to improve the efficiency of the mentioned laser processes. In addition, industrial micro-processing systems equipped with a high power ultra-short pulsed laser have the ability to produce structures with micro- or submicrometer features that can be used to improve to functionalities of surfaces. One of the most efficient structuring technologies capable to produce well-defined periodic micropatterns on a variety of materials with high throughput is Direct Laser Interference Patterning (DLIP). However, although there is a range of monitoring technologies available on the market, monitoring systems have rarely been used to optimize the DLIP process.

In the LAMpAS project, a high-speed infrared camera is used to detect the thermal effects during the laser process. By means of this camera, heat accumulation effects can be detected and analyzed. These heat effects have shown to affect the resulting quality of the surface patterns and the recorded signal of the infrared camera can be used to qualitatively determine a quantitative correlation with the structured surface quality. Simultaneously, a diffraction measurement system is implemented to analyze the quality of the fabricated periodic patterns by comparing the characteristics of the diffraction orders. This specific combination of these two systems enables new possibilities of high-performance process monitoring and quality assurance.



SEM images of structured stainless steel samples in a bad (a) and good surface condition (b) and corresponding maximum intensity of the infrared signal captured by the infrared camera as function of the process position during the laser treatment representing the different surface conditions.

Sponsored by: European Union Horizon2020
An initiative of the "Photonics Public Private Partnership" - Photonics21.org

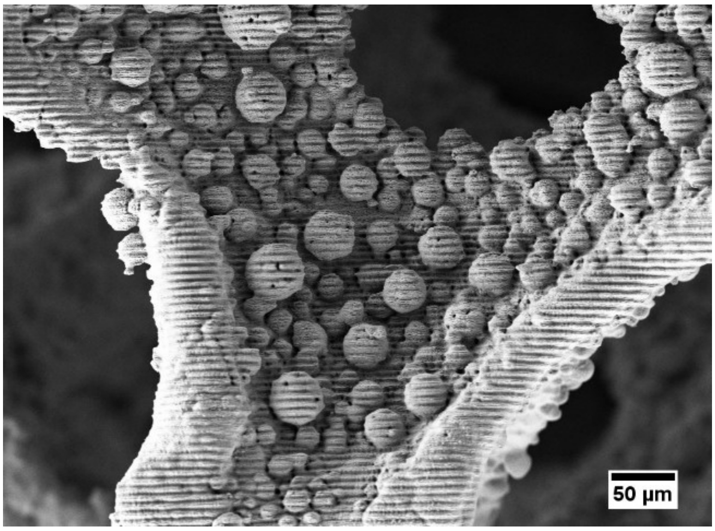
LAMPAS – Project: Laser Structuring of Open Cell Metal Foams for Micro Scale Surface Enlargement

Funding agency: European Union – Photonics21
Period: 01/2019 - 12/2021
Project partners: LMO, Trumpf, Lasea, NIT, NextScan, Bosch, BSH, EPIC
Project managers: Dr.-Ing Robert Baumann

Nowadays, innovative materials have gained an increasing market share in several industrial fields. One of these novel materials are open cell metal foams. Those can be found in different industrial applications such as in batteries, implants, or chemical filters since high surface-to-volume ratios are needed.

In the past, laser technology highlighted the solution for various challenges concerning the performance improvement of open cell metal foams. The performance of several of these properties can be further improved using laser-based fabrication methods allowing the production of repetitive periodic structures on the micrometer or sub-micrometer scale, such as Direct Laser Interference Pattering (DLIP). The task of this work consists of DLIP for structuring the surface of an open cell steel foam. By controlling the laser parameters as well as the geometrical arrangement of the beams, 5.2 µm deep structures with a spatial period of 5.8 µm were fabricated. Afterwards, the surface enlargement of the DLIP-structured foams are electrochemically characterized by determining the double-layer capacitance using cyclic voltammetry (CV) as well as electrochemical impedance spectroscopy (EIS).

The investigations revealed an increase of capacitance in comparison of unstructured foam to DLIP enhanced foam, of a surface enlargement factor of almost 100 %.



SEM image of structured open cell metal foam, spatial period 5.8µm, line-like patterning.

Sponsored by: European Union Horizon2020
An initiative of the "Photonics Public Private Partnership" - Photonics21.org

PHOTONICS21
PHOTONICS PUBLIC PRIVATE PARTNERSHIP

InGRAVE: Integrated engraving and impression process for the one-step manufacture of hierarchical, multifunctional embossing structures

Funding agency: Sächsische Aufbaubank (SAB)
Period: 10/2017 - 03/2021
Project partners: LMO, Sächsische Walzengravur GmbH (SWG)
Project manager: Dr.-Ing. Yangxi Fu

Featuring low-density, flexibility, ease of processing and cost-effectiveness, polymers have been widely used in both daily life and industry. In this project, surface wettability on polyethylene terephthalate (PET) and poly(methyl methacrylate) (PMMA) were studied because of their broad range of applications. A rapid and inexpensive two-step approach was developed to generate periodic pillar-like microarrays on PET and PMMA foils by utilizing Direct Laser Interference Patterning (DLIP) combined with hot embossing.

The surface wettability was evaluated by the experimental measurements of static and dynamic WCA as well as the theoretical calculation based on Wenzel and Cassie-Baxter models. The static contact angles of untreated flat PET and PMMA were 81°and 64°, respectively. After imprinting, the wettability of PET (PMMA) was turned to a hydrophobic state with a maximum WCA up to 139° without any chemical modification. WCA on both polymers presented an upward trend with the aspect ratio. Take PET as an example, the WCA of which ranged from 91° to 139 as the aspect ratio increased from 12 to 57%. According to the theoretical calculation, the measure WCA lied between the calculated Wenzel and Cassie-Baxter WCA. Therefore, it can be assumed that the rough surfaces produced on both PET and PMMA adopt neither Wenzel nor Cassie-Baxter states, but an intermediate state, namely composite (or mixed) wetting state. In this state, the water droplet partly sits on air pockets as well as it partly penetrates the valleys of the rough solid surface. The average hysteresis of PET and PMMA presented a similar value of 19°, indicating a high stickiness of imprinted surfaces. As shown in Fig. 1(c), droplets remained immobile and stuck to the microstructured areas on PET even when the sample is turned upside down (rose petal effect).

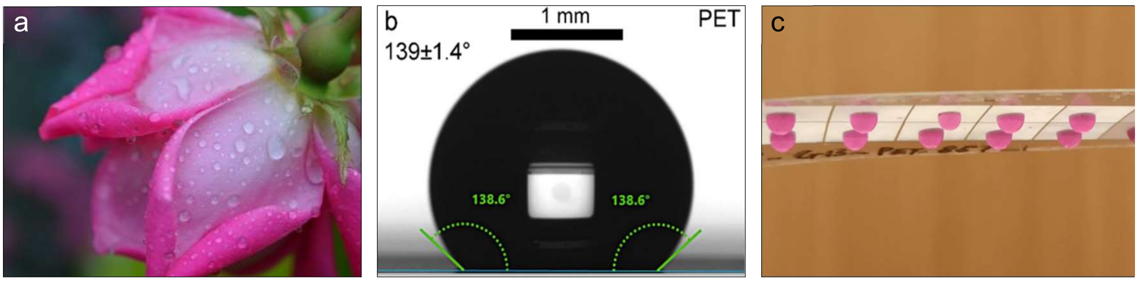


Fig. 1(a) Optical image of water droplets on rose petals. (b) WCA on the patterned PET surface. (c) Photographs of water droplets (dyed by 0.1% KMnO4 solution) on PET film with a tilting angle of 180°.

Sponsored by:
Sächsische AufbauBank (SAB)

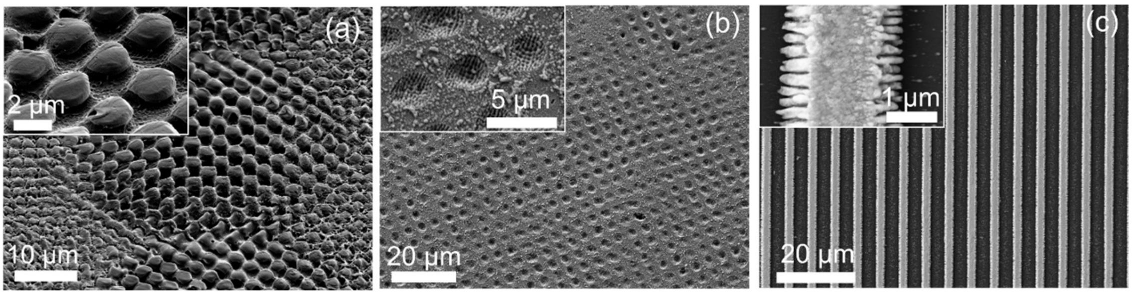
Surface patterning of transparent materials for optoelectronic applications

Funding agency: Alexander von Humboldt Foundation
Period: 04/2018 - 09/2021
Project partners: LMO, IAPP, HZB
Project manager: Dr. Marcos Soldera

The development of organic and perovskite-based optoelectronic devices has attracted much attention in recent years. These emerging materials have great potential to become a cost-effective alternative to traditional technologies, such as silicon photovoltaics and inorganic LEDs. One obstacle, however, is the still low cost-effectiveness due to the relatively low efficiency of the organic and perovskite-based devices, especially when they are fabricated on large area substrates. A strategy to increase the performance of these novel devices is to introduce advanced light-management concepts without altering their electronic behavior.

In this project, transparent substrates are patterned with periodic surface microstructures to induce the diffraction of incoming light into multiple modes. On the one hand Direct Laser Interference Patterning (DLIP) is used to engrave repetitive textures on sodalime glass and transparent conductive oxides, such as ITO. On the other hand, DLIP is also used to pattern metallic stamps to be used in hot embossing processes to imprint polymeric materials, such as PET or PMMA. It is the aim of this project to assess the light management capability of these structured materials and to test their ability to enhance the performance of optoelectronic devices, such as perovskite solar cells, OLEDs and organic photodetectors.

Preliminary tests with perovskite solar cells deposited on PET substrates with hierarchical, line-like structures with spatial periods of 0.45 µm and 2.7 µm showed an efficiency increase of 5%. Likewise, OLEDs featuring a PET out-coupling layer with a pillar-like array presented an increase in the quantum efficiency by 10%.



SEM images of patterned (a) PET with pillar-like array, (b) sodalime glass with hole-like texture and (c) ITO film with line-like grooves.

Sponsored by:
Alexander von Humboldt Foundation

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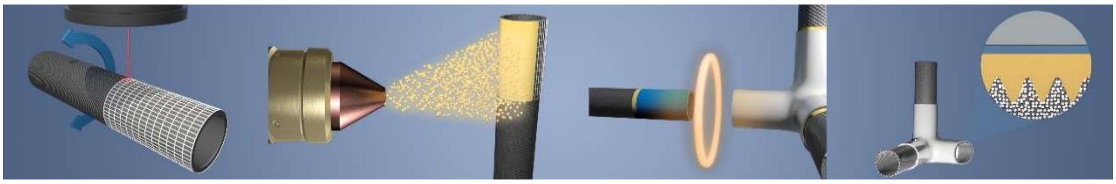
Alexander von Humboldt
Stiftung / Foundation

Enhanced joining of surfaces by laser processing of fiber-reinforced plastics

Funding agency: Sächsische Aufbaubank
Period: 04/2019 - 09/2021
Project partners: Fraunhofer IWS and Chemnitz University of Technology
Project manager: Jana Gebauer

Replacing heavy metal structures with high-performance fiber-reinforced plastics (FRP) offers enormous potential for saving resources and exhaust gases, especially for moved parts like in automotive sector.
For this, the development of a new joining technology for even lighter and more loadable vehicle bodies is focused on this project. Technological solutions for high-strength and long-term joining of fiber-reinforced plastic with metal components are investigated. Goal is the development of a process chain consisting of surface treatment of the FRP, metallization of the pre-treated surface and joining the metalized FRP to a metal component by soldering. Established mechanically based surface modification treatments (e.g. grit blasting) are less suitable for FRP with its sensitive surface. Thus, one objective of this project is the process development of laser surface patterning of FRP. This surface pre-treatment achieves an optimal bonding of the subsequently generated metallic thermally sprayed coating. It provides the necessary conditions for the second goal, the final materially joining of metallized FRP with a metal counterpart using a low-temperature soldering process.
The possibility of thermally depositing firmly adhering layers on notch-free substrates opens up a wide range of possible applications - even beyond the joining process being addressed in this project. For example, plastic-based components can be provided with metal surface properties to increase wear resistance, media resistance or electrical conductivity. Subsequent joining processes enable metallized lightweight structures (FRP-based) to be joined with metal components.
Laser surface pre-treatment or functionalization can be implemented both locally and on large areas. For the economic processing of large areas, it is necessary to scale up the structuring process. Within the scope of this research project, therefore, a parallelization of the process by means of multiple laser beams using diffractive optical elements (DOE) is to be implemented. This is significantly reducing the processing time.



Schematic process chain (f.l.t.r.): Laser pre-treatment, thermal spray coating, soldering and a materially bonded multi-material joint © Fraunhofer IWS

Sponsored by:
Sächsische Aufbaubank and EFRE

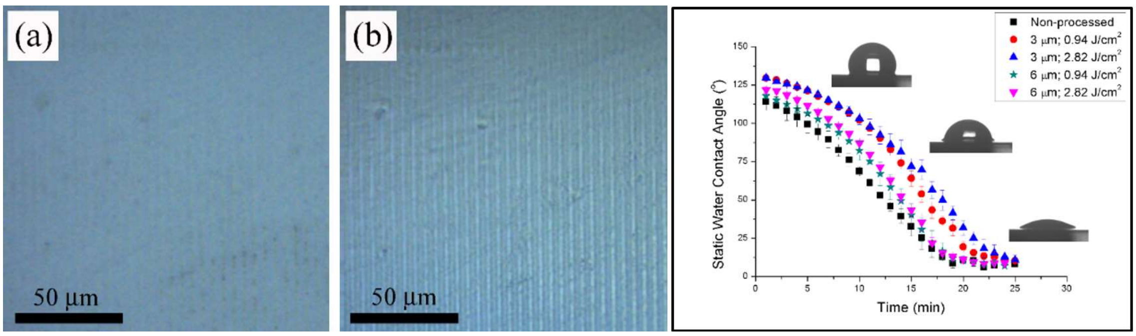
European Union
Europe funds Saxony.
EFRE
European Regional Development Fund

Direct Laser Interference Patterning of Ophthalmic Polymers

Funding agency: European Union – Marie S. Curie IF-795630
Period: 04/2019-01/2020
Project partners: TU Dresden, VOPTICA S.L.
Project manager: Dr. Daniel Sola

Short and ultrashort laser pulses have been widely applied to fabricate two- and three-dimensional permanent structures inside transparent optical materials such as waveguides, photonic crystals, diffraction gratings. During the last decade ultra-fast laser inscription (ULI) has been proposed as a new approach to change the power of refractive optical elements for ophthalmic applications. Nevertheless, the time required to process areas of similar dimensions to that of the cornea, even at the maximal scanning speed reported to date (20 mm/s) is too low and makes this technique inviable to be applied at real scale.

The general objective of this project was to develop new functional materials by means of the Direct Laser Interference Patterning technique for ophthalmic applications. In particular, DLIP was used to modify poly-hydroxyethyl-methacrylate (PHEMA) polymers and Safrofilcon-A hydrogels. These polymers are commonly used as soft contact lenses. In addition, these polymers were structured by using Direct Laser Writing (DLW) to compare both laser-structuring techniques. Topography of the structured areas was evaluated by means of confocal microscopy, and micro-Raman spectroscopy was used to assess the microstructural and chemical properties of the laser-structured areas. Finally, optical characterization was carried out in the processed areas to evaluate the modification of the refractive index. DLIP was found to be more efficient, resulting in refractive index changes up to one order of magnitude higher than those obtained by using DLW. In addition, the processing time to produce the structured areas by using DLIP was nearly 3 orders of magnitude faster than using DLW. Hydration properties of DLIP-structured areas were evaluated by using static water contact angle (WCA) measurements with deionized water.



Bright field (a) and phase contrast (b) images of DLIP structured PHEMA, and time-dependent static water contact angle measurements performed during the absorption of the water droplet by the polymer samples

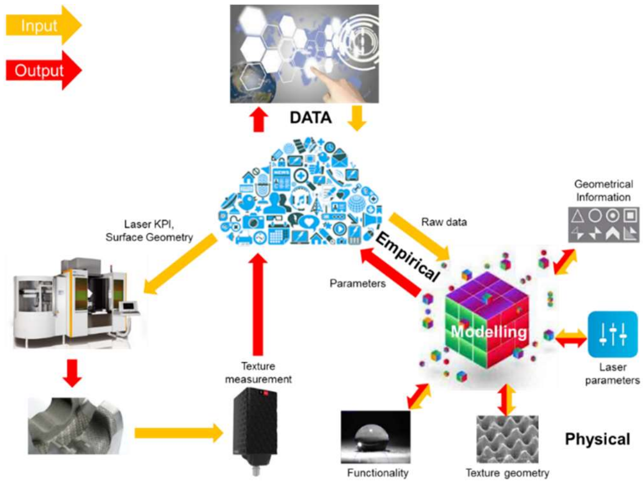
Sponsored by:
European Union's Horizon 2020
research and innovation
programme

European Commission

Laser surface engineering for new and enhanced functional performance with digitally enabled knowledge base (SHARK)

Funding agency: European Union's Horizon 2020
Period: 01/2017 - 03/2021
Project partners: Fraunhofer IWS (CAMP partner)
Project manager: Dipl.-Ing. Tobias Steege

Surface engineering is a key discipline for providing surfaces with advanced functions. Currently, the surface engineering market dominated by coating systems, mainly due to the higher level of maturity of these techniques in addition to the relatively low cost. Laser surface texturing, on the other hand, requires fulfilling additional tasks for several applications fields. The main reasons for these drawbacks are related to typical high processing costs, poor productivity and finally lack of knowledge.
To address the technology's shortfall, a consortium of technology providers, research organizations and end users was formed to revolutionize laser surface texturing methods. SHARK unlocked the potential of laser texturing for creating functional surfaces by increasing the productivity, efficiency and flexibility of the process. This provides European industry with a highly robust, cost-effective and environmentally friendly system capable of producing a wide range of functional surfaces with industrial-scale throughput, giving Europe an unassailable lead in this key area of manufacturing.
The project focused on the four key elements of the surface functionality design cycle, namely design, processing, inspection and test, with all of these elements linked together through digital engineering to deliver the complete solution right-first-time. Industrialization was demonstrated through four end-user case studies in the tooling, medical, food, beverage, and power generation sectors.



The concept of SHARK project

Sponsored by:
European Union's Horizon 2020
research and innovation programme
under Grant Agreement No. 768701

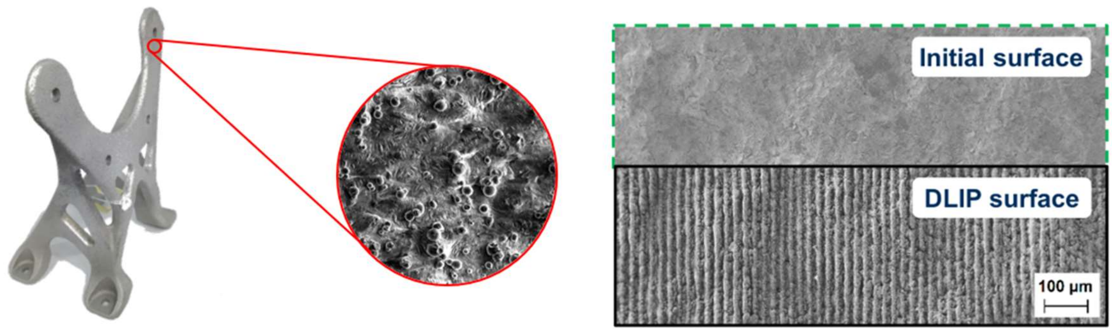
European Union

SHARK
INDUSTRIALISING LASER
FUNCTIONAL TEXTURING

Additive Manufacturing of functional and Effective Light Use-cases

Funding agency: BMBF, Projektträger Karlsruhe (PTKA)
Period: 07/2019 - 06/2022
Project partners: Fada-Catec, CT-Ingenieros, Airbus, Pulsar Photonics
Project manager: Dipl.-Ing. Florian Kuisat

The main project aim of A-MELIUS is the improvement of additive manufactured aerospace components, having an impact in their efficiency by means of lightweight design, better surface quality and therefore mechanical performance, together with the possibility of functionalizing ad-hoc surfaces. This will be achieved by improving the production and testing process of AM parts, as well as the development of laser-based technologies for influencing the surface topography and chemistry of titanium and aluminum alloys. In addition, new properties, such as ice-repellent or aerodynamically flow-optimized surfaces should be generated. At the end of the project, demonstrators will be manufactured and analyzed with regard to their surface and stability properties.
The research work carried out shows a clear modification of the surface topography with the result of a smoothed and textured surface due to the utilization of direct laser writing and direct laser interference patterning technology, respectively. The functionality of the AM components was determined by evaluating the wetting and icing properties. For example, the water contact angle between the as-manufactured surface and laser-textured surface of the aluminum alloy could be increased from 16° to 131° due to the micro-texture. In the future, further investigations into fatigue life will be conducted, which could also extend the applicability of additive manufactured components beyond the state of the art.



Example of additive manufactured 3D component and exemplary SEM images of the surface topography before and after direct laser interference patterning.

Sponsored by:
German Federal Ministry of
Education and Research (BMBF)

Federal Ministry
of Education
and Research

6. Other activities

9th and 10th International Summer School on “Trends and new developments in laser technology”

In cooperation with the Fraunhofer Institute for Material and Beam Technology (IWS) in Dresden, the Chair of Large Area Laser Based Surface Structuring held a four-day international summer school in August 24-27 2020 and in August 23-26 2021. International PhD students could intensively learn about the basics and applications of laser technology and discuss the latest developments.
The main program consisted of lectures by laser experts and practical training in the laboratories of Fraunhofer IWS. Some of the topics covered by the summer school were surface hardening, high-speed 2D laser cutting, laser welding, additive manufacturing processes and applications of ultra short-pulsed lasers between others.
The exchange of ideas was further promoted by presentations of participants. With its extensive technical equipment, the Fraunhofer IWS Dresden offered excellent conditions for the participants.

Participants from all over the world joined the virtual Summer school, for example from Singapore, United States, Ireland and Italy. Besides the professional exchange, the students had an excellent opportunity for networking. The summer school will be offered again in 2022.

International Workshop on “Laser precision micromachining and material-beam interaction“

In cooperation between the TU Dresden and the Universidad Nacional de Cordoba (Argentina), the first international course on "Laser Micromachining and Surface Functionalization" took place in April 2021. About 20 students and PhD students from different countries, including Argentina, Colombia, Cuba, Germany and Venezuela participated in the four-week event. The program consisted of lectures by laser experts and practical exercises to introduce the participants to the fundamentals and applications of laser-based technologies. All students who performed the final oral examination at the last day of the course received a certificate of participation, which is recognized as a course credit and as a qualification for PhD programs.

Following the pilot project, Professors Lasagni and Pino are making plans for long-term collaboration opening the international exchange and cooperation opportunities with Latin America.

Special Issue on Laser Micro and Nano-material processing in Advanced Optical Technologies

Edited by Jörn Bonse and Andrés F. Lasagni, a special issue on laser precision fabrication has been lunched in the journal Advanced Optical Technologies. The issue describes about recent technological developments that will open new perspectives for industrial applications of laser surface structuring in the near future. This has become possible due to a continuous reduction of the cost of the laser sources as well as the outstanding improvement of their performance. Simultaneously, a wide-range of methods and optical systems permit today, the efficient processing of different materials with high precision, which is fundamental for reaching the product demand.

DE GRUYTER Adv. Opt. Techn. 2020; 9(1-2): 7–9

Editorial

Jörn Bonse* and Andrés Fabián Lasagni*

Laser micro- and nano-material processing – Part 1

https://doi.org/10.1515/aot-2020-0009

This special issue of *Advanced Optical Technologies* (AOT) is dedicated to the field of laser-based micro- and nano-structuring methods. Due to the unique characteristics of pulsed laser systems, among them ultrafast sources with picosecond and femtosecond pulse durations, today we are experiencing an explosion of new technological developments that will open new perspectives for industrial applications in the near future. This becomes possible due to a continuous reduction of the cost of the laser sources as well as the outstanding improvement of the power stability, increased pulse repetition frequencies, as well as the simplicity of the new laser sources.

However, although these developments are necessary for boosting the availability of lasers in modern industrial manufacturing, they will not alone define the industrialization of laser-based applications. In this context, additional efforts are still necessary for understanding how specific surface functionalities on different materials can be created or even improved by developing specific textured surfaces as well as how to produce these topographies at high-throughput by the full utilization of the laser performance.

Our list of contributors for this issue reflects a leading-edge mix of experts in these areas, from all around the world. The special issue is published in two parts.

Part 1 of the special issue *Laser Micro- and Nano-Material Processing* contains three review articles and four more original research articles that are briefly summarized here:

Gräf discusses in a review article the fundamentals, properties and applications of laser-induced periodic surfaces structures (LIPSS). The article reveals the physical background of LIPSS on different kinds of materials and provides a description of relevant applications including structural colors in surfaces, wetting states or the modification of tribological properties. Short comments on future developments and perspectives related to forthcoming applications of LIPSS-based surfaces are also discussed.

The review article by Nivas et al. provides new ideas about the direct fabrication of complex surface patterns on silicon using femtosecond laser radiation in an optical setup that permits obtaining light beams with different spatial intensity distributions using q-plate beam converters. Within the novel developed surfaces, the authors present simpler azimuthal, radial and spiral shapes as well as very complex textures in which nanosized LIPSS and micro-scaled grooves are found following the local state of linear polarization manifested in the complex light beams.

Klein-Wiele et al. present a review article on diffractive beam management-based fabrication techniques of repetitive surface structures on various materials using ultrashort ultraviolet laser radiation. This is conducted by overlapping two or more coherent laser beams and thus creating interference patterns. The generation of the interfering beams is accomplished by diffractive optical elements like gratings, grating systems or computer generated holograms.

Alamri et al. report on the fabrication of repetitive structures using direct laser interference patterning (DLIP). In this case, they evaluate the processability of glass material by using an interference optical configuration using nanosecond-pulsed lasers with infrared radiation. The reported technology is based on irradiating a metallic absorber which is put in direct contact with the glass sample and locally inducing an etching process on the backside of the glass. Different topographic geometries are presented including like and dot-like structures obtained by the superposition of two and four laser beams, respectively.

Batal et al. employ two different fs-laser surface texturing strategies based on defocusing or sample tilt for

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Argentine Ambassador visits the TU Dresden

Argentinian Ambassador Pedro Villagra Delgado visited the Technische Universität Dresden on Tuesday 2 November. He was received by a committee of the TUD, consisting of Prof. Dr. Ronald Tetzlaff (Chief Officer Technology Transfer and Internationalization), Prof. Dr.-Ing. Andrés Fabián Lasagni (holder of the Chair of Large Area Laser Based Surface Structuring) and Peter Rosenbaum (Head of International Affairs).

During the meeting, the ongoing cooperation activities between TU Dresden and Argentina as well as possible future joint topics were discussed. Afterwards, the ambassador had the opportunity to meet current KOSPIE-DAAD scholarship holders from Argentina who are already studying at TU Dresden.

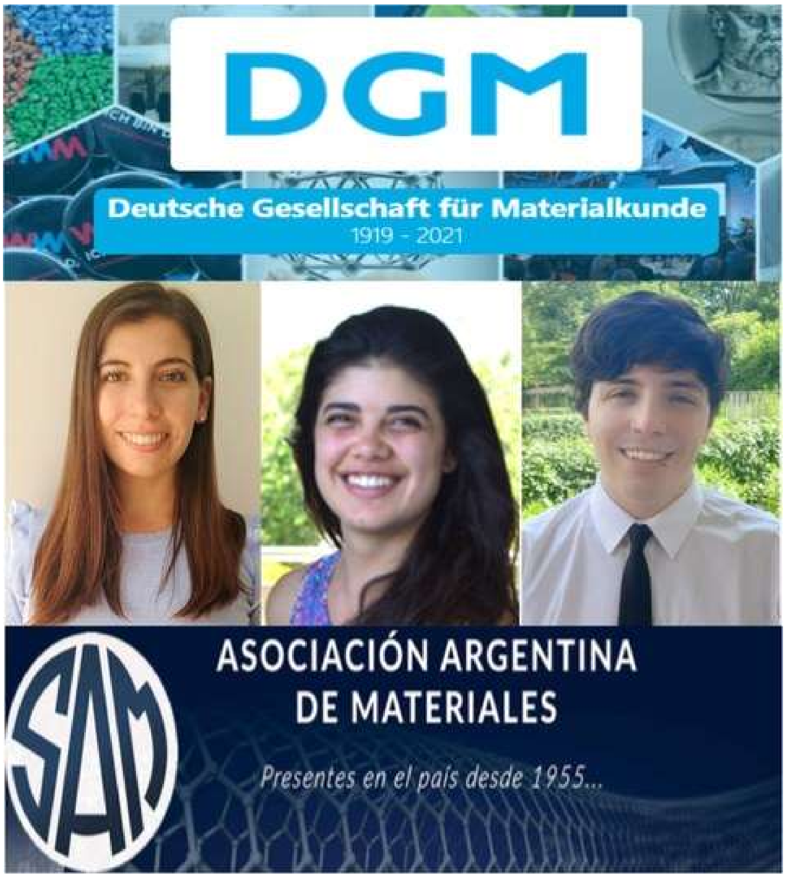
Finally, Prof. Lasagni and his team (see photo) guided the Argentine delegation through the laboratories of the Chair of Large Area Laser Based Surface Structuring.

In the picture (from left to right): Herman Heffner, Alexander Bock, Lis Geraldine Zschach, Dr. Pedro Raúl Villagra Delgado, Prof. Dr. Andrés Lasagni, Dr. Robert Baumann, Dr. Lucinda Mulko and Dr. Marcos Soldera.

Argentinean and German associations of Materials science create a new young international cooperation team

The Deutsche Gesellschaft für Materialkunde e.V and the Asociación Argentina de Materials created a young international team, with the aim of sharing knowledge between both nations as well as to increase cooperation in the future.

We congratulate our team member Herman Heffner (DAAD scholarship) for his efforts as well as Josefina Dib and Victoria Guglielmotti.



RCAA-Webinar about the Fraunhofer Association and its contribution to innovation in Germany

Andres Lasagni gave a live webinar in the framework of a series of webinars organized by the Network of Argentinian Researchers in Germany (RCAA). The talk was about the role of the Fraunhofer Association as a key player in the German scientific system to develop applied research and transfer it to industry and society in general.

Member of the scientific committee at the Laser-based Micro- and Nano-Processing IX Conference at Photonics West 2020 and 2021 in San Francisco, USA

In February 2020 and 2021, Prof. Lasagni participated as a member of the committee at the "Laser-based Micro- and Nano-Processing IX" conference. The conference was held in San Francisco (USA) and focused on the development of different areas of laser technology. These include laser-based micro- and nanostructuring, direct laser writing and surface modifications.

Member of the scientific committee at the Laser Microprocessing Conference at ICALEO, USA

The International Congress on Applications of Lasers & Electro-Optics (ICALEO®) has a 39-year history as a conference where researchers and end users meet to discuss the state of the art and future developments within laser materials processing, laser micro- and nano-processing. In October 2020 and 2021, Prof. Lasagni was a member of the scientific committee of the Laser Microprocessing Conference. The subject of the conference is the research of applications, processes and beam sources in laser material processing.

Symposium-coordinator at XIX Brazil MRS Meeting, September 2021 (on-line)

In September 2021, Prof. Lasagni and Prof. Henriques coordinated the symposium “Photonic Materials and Processes: patterning, physical properties and applications“. With more than 1000 participants, the congress allowed a strong exchange of experiences in the field of materials science and materials engineering.

Symposium-coordinator at EUROMAT 2021, September 2021 (on-line)

In September 2021, Prof. Lasagni coordinated the symposium “Laser-based processing and manufacturing“. EUROMAT is the premier international congress in the field of materials science and technology in Europe.

Symposium and topic coordinator at MSE 2020, September 2020, Darmstadt, Germany

In September 2020 Prof. Lasagni coordinated the topic F: "Functional Materials, Surfaces and Devices" at the Material Science and Engineering Congress (MSE) in Darmstadt. He also coordinated Symposium F08, related to “Photonic technologies for surface processing”.

Chair of the "Laser Precision Microfabrication 2020" conference and Member of the scientific committee at the "Laser Precision Microfabrication" conference

In 2020, Prof. Lasagni was conference chair of "Laser Precision Microfabrication 2020" congress. He also participated actively at other committees of the conference, such as the program and steering committees.

Member of the scientific committee at the "Laser Precision Microfabrication 2021" conference

In 2021, Prof. Lasagni participated as a member of the committee at the "Laser Precision Microfabrication" conference (LPM). The theme of the conference was research into applications, processes and beam sources for laser materials micromachining and was held virtually.

Member of the scientific committee at the "Lasers in Manufacturing (LiM 2021)" conference, in Munich, Germany

In June 2021, Prof. Lasagni attended the "Lasers in Manufacturing (LiM 2021)" conference as a member of the committee. The LiM focuses on the latest developments and future trends in the field of laser material processing. The conference topics are addressed to all who are interested in the potential of lasers in manufacturing, theory and application.

7. Prizes and awards

Prof. Andrés Lasagni elected member of the Saxon Academy of Sciences

The Saxon Academy of Sciences in Leipzig has elected Andrés Fabián Lasagni as a full member of the Technical Science Class. With this appointment, the TU Dresden professor joins the list of more than 200 renowned members of various disciplines. During the hybrid public fall session of the Academy on December 11, 2020, Lasagni was formally admitted to the Academy in the presence of Sebastian Gemkow, Minister of State for Science of the Free State of Saxony.

Since its foundation as the Royal Saxon Society of Sciences and Humanities in 1846, the Saxon Academy of Sciences in Leipzig has been committed to the tradition of the Leibniz-influenced academy concept of bringing together leading scientists from a wide range of disciplines for regular discourse and to conducting long-term research in the catchment areas of Saxony, Saxony-Anhalt and Thuringia.

Currently, the Academy is engaged in more than 20 projects, many of them in close cooperation with universities, colleges and non-university research institutions – the goal of basic research in the humanities is the printed and digital indexing, securing and visualization of cultural world heritage. In numerous series of events, experts from science and politics are invited to advance the public discourse on current social and science policy issues - a transdisciplinary dialogue that is also continued in the academy journal "Denkströme".

DGM Young Talent Award 2019 for Dr. Christoph Zwahr

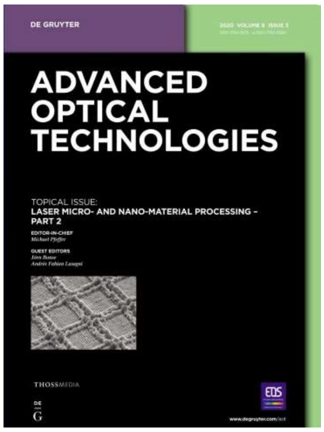
Christoph Zwahr was awarded the DGM Young Scientist Award 2019 (the award is given always one year later) for his for his contributions to the development of functionalized titanium surfaces by laser-based processes, which are used in high-quality dental implants, as well as for the conception of a technological solution for the rapid processing of three-dimensional surfaces.

The Young Investigator Award is aimed at doctoral students from non-profit research in the field of materials science and materials engineering. Recipients of the award have a completed university degree and have demonstrated an outstanding performance based on his or her work results. In the pictures: Award ceremony during the DGM-Day in September 2020. Left; Dr. Christoph Zwahr; right: Dr. Oliver Sven Schauerte and Prof. Frank Mücklich (DGM presidents).

Cover page in Advanced Optical Technologies Journal (9/2020)

The article "Modification of Ti6Al4V surface properties by combined DLW-DLIP hierarchical micro-nano structuring" published with our CAMP team as well as the Universidad Politécnica de Madrid (Spain) was awarded with the title page of the international journal "Advanced Optical Technologies".

The cover page shows a hierarchical structure produced using DLIP and DLW methods, reaching resolutions up to the sub-micrometer level.



Best oral presentation at LPM 2020, web-conference

Sabri Alamri, from CAMP (TU Dresden, Fraunhofer IWS), received the best student oral presentation award at the 21st International Symposium on Laser Precision Microfabrication (LPM2020). For more than two decades, LPM has been one of the most important international conferences in the field of laser material micro processing.
Talk title: Direct and indirect glass texturing employing interference-based methods.

Best student poster award (I) at LPM 2020, web-conference

Stephan Milles, received the best student poster award at the 21st International Symposium on Laser Precision Microfabrication (LPM2020). His talk was related to the "Wetting properties of the aluminum surface structures fabricated using Direct Laser Interference Patterning with picosecond and femtosecond pulses"

Best student poster award (II) at LPM 2020, web-conference

Christian Bischoff also received the best student poster award at the 21st International Symposium on Laser Precision Microfabrication (LPM2020). The title of his poster was "Homogeneous intensity within the Rayleigh length and enhanced depth of focus for Gaussian beams".

Best student poster award (1st prize) at Laser Symposium & ISAM 2021

Michael Seiler received the 1st prize for the poster award during Laser Symposium & ISAM 2021 (December 2021) for the worked entitled "Process window for selective metallization of PC with picosecond laser radiation".

8. International cooperation

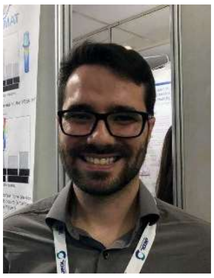
Dr. Marcos Soldera, Instituto de Investigación y Desarrollo en Ingeniería de Procesos, Biotecnología y Energías Alternativas (PROBIEN, CONICET-UNCo), Argentina
Location: LMO, IF, TU Dresden
Duration: 01/04/2018 – 30/09/2021
Program: Alexander von Humboldt Foundation

Dr. Daniel Sola, Laboratorio de Óptica (LO·UM), Centro de Investigación en Óptica y Nanofísica (CIOyN), Spain
Location: LMO, IF, TU Dresden
Duration: since 01/04/2019
Program: Marie Skłodowska-Curie (LMO)

Prof. Dr. Bruno Henriques, Mechanical Engineering Department, Universidade Federal de Santa Catarina, Brazil
Location: LMO, IF, TU Dresden
Duration: since 15/11/2019
Program: Alexander von Humboldt Foundation

Hermann Heffner, Instituto de Química del Sur, Universidad Nacional del Sur, Bahía Blanca, Argentina.
Location: LMO, IF, TU Dresden
Duration: since 01/04/2021
Program: sandwich DAAD scholarship for PhD students

Lis Geraldine Zschach
Location: LMO, IF, TU Dresden
Duration: since 01/10/2021
Program: DAAD scholarship for PhD students



Fabris Douglas, Universidade Federal de Santa Catarina, Florianopolis, Brazil

Location: LMO, IF, TU Dresden
Duration: since 15/11/2021
Program: sandwich DAAD scholarship for PhD students

9. Completed thesis

9.1 PhD theses

Cindy Goopold (2020):

Innovative concept of beam oscillation for efficient laser beam fusion cutting

Laser beam fusion cutting of thick plate metal requires a compromise between productivity and cut edge quality. This is due to the interfering process mechanisms of heat conduction and melt ejection. It is not possible to eliminate this dependency by using static beam shaping. The present thesis investigates the influence of dynamic beam oscillation as a novel concept. As a result, both productivity and cut edge quality of the cutting result are significantly increased. This was identified on the basis of the performance criterion, which includes cuttings peed, burr height and cut edge roughness. The decisive factor is a changed energy deposition. While static beam shaping continuously applies laser energy, this occurs gradually during beam oscillation. Another decisive fact is the increase of the interaction time due to beam oscillation. By means of high-frequency and spatially resolved temperature measurement, it is shown for the first time that this results in a highly volatile temperature profile with very high maximum temperatures and sequential cooling. Beam oscillation thus proves to enhance the heat transport during laser beam fusion cutting of thick plate metal and thus achieves highest productivity. The identified quality improvements, such as reduced burr adhesion, indicate a positive influence of beam oscillation on the melt ejection.

Vittorio Vercillo (2020):

Durable Laser Patterned Metal Surfaces with Enhanced Icephobic Properties for Aerospace Applications

Ice accreting on external aircraft surfaces due to the impact of supercooled water droplets can negatively affect their aerodynamic performances and diminish their operational capability. Therefore, it must be prevented. Icephobic surfaces capable of reducing the adhesion strength of ice to a surface and to reduce or delay the ice accretion represent a promising technology to support thermal or mechanical ice protection systems. In this work, short/ultra-short pulsed laser treatments are investigated as a viable technology to generate superhydrophobic/icephobic properties on the surface of alloys commonly used for aerospace components.

Metals treated with Direct Laser Interference Patterning (DLIP) shows the most icephobic properties, reducing ice adhesion strength and decreasing the heating power required to keep the surface free of ice or to remove the ice formed when combined with an active ice protection system. The durability of laser-treated surfaces is assessed over an extended time in operational environment in a flight test campaign on a A350 test aircraft.

Sabri Alamri (2020):

Advanced Microstructuring Strategies of Polymers using Direct Laser Interference Patterning

The challenge of reproducing natural microstructured surfaces, together with their function, on manmade objects and devices engaged materials scientists since decades. In particular, polymeric materials are frequently used in a wide variety of products because of their good mechanical properties, ease of processing, lightweight, transparency and low production costs. However, due to their optical properties, the laser micromachining of transparent materials as polymers and high bandgap dielectrics requires the use of ultraviolet or ultrashort pulsed lasers. This dissertation focusses on advanced strategies for the micro-texturing of polymers through interference-based methods, with both the aim to understand laser-matter interaction mechanisms and create novel functions on the treated materials. It has been shown, that unusual ablation profiles can be obtained for the processing of pigmented and transparent polymeric substrates with ultraviolet and infrared laser radiation. As a result, an empirical model is developed for the microtexturing of polymers for better explaining the different texturing behaviors. Based on the control of the ablation profiles, complex strategies for the fabrication of multi-level surface structures are presented too, aiming to tailor wetting properties and to extend the perception of structural colors on transparent surfaces. Further, transparent materials have been textured by means of indirect interference-based methods, enabling the creation of line-like microstructures and the simultaneous embedment of metallic particles on the surface. Moreover, the direct fabrication of microstructures having a non-symmetrical morphology with controllable inclination is reported, whose optical properties revealed similarities with blazed diffraction gratings.

Dmitriy Mikhaylov (2021):

Ultrashort Pulse Laser Ablation of Bulk Materials Using Shaped Laser Beams

High precision, high quality and high throughput of ultrashort pulse laser ablation of bulk material are the most demanded properties that are required to let this process technology compete with other micro-machining techniques. Previous attempts to increase volumetric ablation rates of ultrashort pulse laser processes were based on the increase of fluence or pulse repetition rates. They run into limitations mainly set by the occurrence of bumpy surfaces due to overheating of bulk material.

In this work, the potential of laser beam shaping for the enhancement of ablation rates is studied systematically for the first time. The question regarding the physically shortest possible process time for ablation of 2.5D-structures by means of an ultrashort pulse laser is answered using a heat conduction model, which is extended by the ability to consider spatially shaped beams. The strategy of laser beam stamping is implemented in a novel optical setup and proven both theoretically and experimentally to have a great potential for increasing ablation rates.

Alfredo Ismael Aguilar Morales (2021):

Microfabrication and development of multi-scaled metallic surfaces using Direct Laser Interference Patterning

Surface modification up to the nanometer range can be carried out through laser surface texturing technologies such as Direct Laser Interference Patterning (DLIP) and Direct Laser Writing (DLW). Thereby, defined and well-controlled patterns in the micro- and nanometer range can be produced on several surface materials. This thesis aims to investigate new approaches to improve micro- and nano-structures fabricated by DLIP and DLW on metals. In order to extend the opportunities in the enhancement of surface properties, the microfabrication of topographies with repetitive distances ranging from 0.2 µm up to 7.2 µm is explored. Subsequently, the impact of DLIP process parameters such as laser fluence, pulse-to-pulse overlap, hatch distance and spatial period, on the surface texture homogeneity is investigated. In that way, a quantitative measurement scheme based on established parameters including mean structure height, standard deviation and kurtosis is introduced. Moreover, the fabrication of hierarchical line- and pillar-like microstructures using picosecond DLIP is investigated as a function of number of pulses and laser fluence. In the context of multi-scaled microstructures, DLW is employed to produce micro-cells ranging from 17 µm up to 50 µm. Afterwards, picosecond DLIP is used to fabricate micro- and nanostructures on the DLW micro-cells. The obtained topography consists of multi-scaled hierarchical micro- and nano topological elements. In order to improve the throughputs in the DLIP process, an analytical ablation model is developed, it allows predicting the resulted microstructure depth in terms of DLIP process parameters. Furthermore, wetting assessment on pillar-like structures is carried out as a function of Filling Factor and the combination of hierarchical and single-scale structures. Optimized superhydrophobic pillar-like structures were fabricated on the surface of a large aircraft part, which allows considering them as promising and feasible structures for surface functionalization on metals.

Cornelius Demuth (2021):

Application of the mesh-free smoothed particle hydrodynamics method in the modelling of direct laser interference patterning

Direct laser interference patterning (DLIP) is a technique to generate periodic microstructures, particularly line-like surface features by two-beam interference, on various substrates. In this work, nanosecond pulsed DLIP of metals is modelled using the mesh-free smoothed particle hydrodynamics (SPH) method to gain insight into the effective physical mechanisms. First, a thermal SPH model for DLIP, including the absorption of laser radiation, heat conduction and the latent heat of phase changes, is developed. The model is complemented with an incompressible SPH approach to the thermocapillary melt pool convection, and applied to DLIP of stainless steel and aluminum. Numerical simulations indicate a shallow pool and less pronounced flow for stainless steel, whereas a deeper melt pool and considerable surface velocity magnitudes result for aluminum. Topographies found after experiments on these materials confirm the predictions. Therefore, Marangoni convection is a conceivable structuring mechanism during DLIP of aluminum at moderate fluences. Regarding DLIP of steel with different sulphur content, simulations, incorporating the non-linear temperature dependence of surface tension, reveal distinct melt pool flow patterns and support the explanation of microstructures created in available experiments..

Stephan Milles (2021):

Development and Application of Industry-suitable Modular Solutions for Direct Laser Interference Patterning

Nature-inspired surfaces provide an endless potential for innovations and exploitations in material science and engineering, especially on aluminum due to the broad range of applications where it can be used. A promising strategy to achieve multifunctionalities is by fabricating micrometer and submicrometer features on the material's surface. Thus, surface texturing of aluminum components is an extremely relevant topic in science and engineering that affects all facets of our lives. Until now, micropatterned aluminum surfaces, that combine water- repellent, self-cleaning and icephobic properties, have not yet been completely explored. The present doctoral thesis focuses on structuring aluminum substrates to fabricate multifunctional surfaces with superhydrophobic, self-cleaning and anti-icing properties. To accomplish this goal, laser-based texturing methods are applied to pattern micrometer and sub- micrometer features on aluminum. They are employed separately to fabricate single-scale textures, as well as in combination in order to obtain multi-scale geometries and complex patterns. The laser texturing parameters are optimized to maximize the addressed functionalities and their influence on the microstructure are studied. In order to explain the wetting and freezing behavior of the functional surfaces, numerical heat transfer simulation models are applied. The most promising textures are then selected and tested under realistic icing conditions simulating the freezing behavior of water droplets on aircraft parts during flight. Moreover, a new method to characterize the self-cleaning efficiency of laser-patterned aluminum is developed. The textured aluminum surfaces attained a water-repellent functionality with a static water contact angle of up to 163° and a sliding angle of 12° without chemical post-processing. This functionality permitted a self-cleaning property where particular structures provided a maximum self-cleaning efficiency with remaining contamination as low as 1 %. The ice-repellent characterization at a temperature of -20°C revealed that in all investigated laser-structured surfaces the freezing time of 8 µl droplets increased up to three times compared to an unstructured reference. Moreover, it was demonstrated, that optimized surface textures led to a reduction of the ice adhesion strength by up to 90 %.

Tobias Baselt (2021):

Selected methods for optimizing supercontinuum generation for use in optical metrology

Supercontinuum generation, especially in glass fibers, is uniquely positioned among broadband light sources as it provides a very high degree of spatial coherence and at the same time high spectral power density, allowing light to be directed into areas that are normally difficult to illuminate. Within the scope of this work, methods for overcoming the power limitation of fiber-based supercontinuum light sources were discussed and selected methods were investigated on application-specific developed supercontinuum light sources. An increase of the spectral power density of supercontinuum light sources in defined spectral ranges was achieved and the power limit set by the damage threshold of the used glass fibers could be overcome. In addition to amplifying a pulsed excitation laser directly in the nonlinear medium, a method to use the cladding of a microstructured fiber to convert the radiation was developed. The use of the cladding of a microstructured fiber as a waveguide allows an increase in area compared to the core of the fiber without a significant change in dispersion characteristics. Supercontinuum light sources have been evaluated for selected optical metrology methods. The developed supercontinuum light sources offer new functionalities for these methods extend the measurement range or shorten the measurement time.

9.2 Master thesis / Diploma works

Christian Müller (2020): *Elektronenstrahlsintern von Solarzellenfrontkontakten aus siebdruckgeeigneten Metallisierungspasten*

Alexander Sürmann (2020): *One-step interference-based microstructuring of glass for improved wetting and tribology applications*

Toste Hoop (2020): *Untersuchungen zur hochdynamischen linearen, longitudinalen Strahloszillation beim Laserstrahlschmelzschneiden von Metallen*

Johannes Dahms (2020): *Herstellung periodischer und hierarchischer Mikrostrukturen auf Aluminium sowie deren Benetzungsanalyse*

Valentin Schneider (2020): *Entwickeln von robotergestützten Methoden zum Hochgeschwindigkeitsbearbeiten dreidimensionaler Oberflächen mit direkter Laserinterferenzstrukturierung*

Julian Lepère (2020): *Generierung von eisabweisenden und superhydrophoben hierarchischen Mikrostrukturen*

George Pätzold (2020): *Entwicklung von Laserstrukturierungsverfahren für automobile Antriebskomponenten im tribologischen Kontakt*

Daniel Herrmann (2021): *In-Line Poliersystem für Präzisionswalzen*

Fabian Ränke (2021): *Laserbasierte Oberflächenmodifikation von additiv gefertigten Bauteilen aus Ti64 und Scalmalloy® zur Beeinflussung des Benetzungsverhaltens*

Conrad Wittig (2021): *Untersuchung des Laserstrahlbrennschneidens mit hochdynamischer Strahloszillation*

Lukas Orlawsky (2021): *Entwicklung einer adaptiven Regelung der Schweißbadtemperatur beim Laserpulverauftragsschweißen*

Tobias Nicolaides (2021): *Process optimization for 2,5 D surface processing with high- frequency picosecond laser*

Stephan Moghtaderifard (2021): *Modelling and validation of microstructure replication on aluminum foils from laser-patterned stamps*

***Patrick Peveling (2021*):** *Entwicklung eines Simulationsmodells zur Untersuchung des Temperaturverlaufes während einer Lasermikromaterialbearbeitung*

Max Menzel (2021): *Fabrication of decorative elements using laser based fabrication methods*

Yasmine Bouraoui (2021): *Lasermikrostrukturierung von Werkzeugeingriffsflächen zur Verbesserung der tribologischen Eigenschaften*

9.3 Other student reports

Mario Goltz (2020): *Hierarchische Strukturierung von PET mittels Platte-zu-Platte Heißprägen laserstrukturierter Oberflächen*

Thomas Litterst (2020): *Untersuchung der Schichtbildung an Schneidkanten unter verschiedenen Prozessbedingungen beim Arc-PVD-Verfahren*

Max Manzel (2020): *Fabrication and Optical Analysis of the Decorative Features Formed by Direct Laser Interference patterning*

Fabian Ränke (2020): *Laserbasierte Oberflächenmodifikation von additiv gefertigten Bauteilen aus Ti64 und Scalmalloy® zur Beeinflussung des Benetzungsverhaltens*

Stephan Wischnewski (2020): *Räumliche Strahloszillation bei der Laser Makromaterial-bearbeitung*

Julius Zöllner (2020): *Konturgenauigkeit im Laserschnitt an einem HDFC*

Hanno Stertz (2020): *Entwicklung eines Adapters zur softwaregesteuerten Relativbewegung zwischen einem Pulverdüsenmessgerät und einer Pulverdüse*

Christoph Seitz (2020): *Entwicklung von Prozessparametern für das Auftragen von Leichtmetallen mittels Laser-Pulver-Auftragsschweißen und deren mechanische Charakterisierung*

Vasco Alexander Berl (2021): *Entwicklung eines Systems zur automatischen Korrektur des Drahtvorstandes beim Laser-Draht-Auftragsschweißen*

Yasmine Bouraoui (2021): *Laser surface structuring for improved wear resistance of cutting tools*

Andreas Reichel (2021): *Oberflächenfunktionalisierung mit DLIP Verfahren zur gerichteten Tropfenbewegung*

Clarita Muntschick (2021): *Charakterisieren eines Laserstrukturierungsprozesses anhand emittierter akustischer Oberflächenwellen*

Franziska Spitz (2021): *Comparative research on friction and wear behavior of laser-manufactured surface microstructures*

Chen Lin (2021): *Ultra-short pulse laser structuring of nickel electrodes for hydrogen evolution-reaction*

Vasco Alexander Berl (2021): *Entwicklung eines Systems zur automatischen Korrektur des Drahtvorstandes beim Laser-Draht-Auftragschweißen*

Charlotte Reichel (2021): *Topographical characterization and statistical analysis of laser textured surfaces for homogeneity estimation*

10. Publications

Peer-reviewed journals

1. L. Mulko, M. Soldera, A.F. Lasagni (2021): Structuring and functionalization of non-metallic materials using Direct Laser Interference Patterning: a review, Nanophotonics (in press).
2. L. Lorenz, T. Chudoba, S. Makowski, M. Zawischa, F. Schaller, V. Weihnacht (2021): Indentation modulus extrapolation and thickness estimation of ta-C coatings from nanoindentation. J Mater Sci 56, 18740–18748
3. L. Cangueiro, D. Bruneel, T. Kiedrowski, N. Schroeder, A. F. Lasagni, J. A. Ramos-de-Campos (2021): Heat accumulation in metals under femtosecond irradiation: simulation and experimentation, PhotonicsViews 5/2021, 30-33.
4. L. Cortella, I. Cestari, M. Soldera, A. Rank, A. F. Lasagni and I. N. Cestari (2021): Conditioning of hiPSC-derived Cardiomyocytes Using Surface Topography Obtained With High Throughput Technology, Biomedical Materials, 16 (2021) 065007.
5. M. El-Khoury, M. Seifert, S. Bretschneider, M. Zawisch, T. Steege, S. Alamri, A. F. Lasagni, T. Kunze (2021): Hybrid processing of bearing steel by combining Direct Laser Interference Patterning and laser hardening for wear resistance applications, Meterials Letters, 130284.
6. B. Michelberger, D. Jaitnerc, A. Hagel, P. Striemann, B. Kröger, A. Leson, A.F. Lasagni (2021): Combined measurement and simulation of piston ring liner contacts with a reciprocat-ing long-stroke tribometer, International Tribology 163, 107146.
7. M. Kovacic, D. Samigullina, F. Bouchard, K. Janez, B. Lipovsek, M. Soldera, A.F. Lasagni, S. Reineke, M. Topic (2021): Analysis and optimization of light outcoupling in OLEDs with external hierarchical textures, Optics Express 29, 23701-23716.
8. F. Kuisat, F. A. Lasagni, A. F. Lasagni (2021): Simultaneous micro-structuring and surface smoothing of additive manufactured parts using DLIP technique and its influence on the wetting behavior, Materials 14, 10, 2563.
9. T. Steege, S. Alamri, A.F. Lasagni, T. Kunze (2021): Detection and analysis of photo-acoustic emission in Direct Laser Interference Patterning, Scientific Reports 11, 14540.
10. F. Bouchard, M. Soldera, R. Baumann, A. F. Lasagni (2021): Hierarchical microtextures embossed on PET from laser-patterned stamps, Materials, 14, 1756.
11. K. Gustke, J. Gebauer, R. Drehmann, A. F. Lasagni, T. Lampke (2021), Enhancement of the Adhesion of Wire Arc Sprayed Coatings on Carbon Fiber-Reinforced Plastic by Surface Laser Structuring, Coatings 2021, 11, 467.
12. S. Milles, J. Dahms, B. Voisiat, S. Indrisiunas, G. Račiukaitis, A. F. Lasagni (2021): Wetting properties of the aluminium surface structures fabricated using Direct Laser Interference Patterning with picosecond and femtosecond pulses, Journal of Laser Micro/Nanoengineering, 16, 1 20-014.
13. T. Jähnig, C. Demuth, A. F. Lasagni (2021): Influence of sulphur content on structuring dynamics during nanosecond pulsed direct laser interference patterning, Nanomaterials, 11, 855.
14. F. Kuisat, F. Lasagni, A.F. Lasagni (2021): Smoothing additive manufactured parts using ns-pulsed laser radiation, Progress in Additive Manufacturing, s40964-021-00168-4.
15. A.-K. Meinshausen, M. Herbster, C. Zwahr, M. Soldera, T. Halle, A. F. Lasagni, J. Bertrand (2021): Aspect ratio of nanostructures determines Staphylococcus aureus adhesion on PET and titanium surfaces, Journal of Applied Microbiology, 15033.
16. A. Madelung, S. Alamri, T. Steege, B. Krupop, A. F. Lasagni, T. Kunze (2021): Scanner-Based Direct Laser Interference Patterning on Stainless Steel, Advanced Engineering Materials, 202001414

17. D. Sola, S. Milles, A.F. Lasagni (2021): Direct Laser Interference Patterning of diffraction gratings in Safrofilcon-A hydrogel: Fabrication and hydration assessment, Polymers, 13, 679.
18. B. Voisiat, S. Milles, A. F. Lasagni (2021): Impact of molten pool dynamics on resultant surface structures during direct laser interference patterning, Journal of Laser Micro/Nanoengineering, 16, 1, 20-024.
19. F. Kuisat, F. Roeßler, A.F. Lasagni (2021): A process optimization strategy for texturing three-dimensional surfaces using Direct Laser Interference Patterning, Advanced Engineering Materials, 2001315.
20. M. Soldera, S. Alamri, P. A. Sürmann, T. Kunze, A. F. Lasagni (2021): Microfabrication and Surface Functionalization of Soda Lime Glass through Direct Laser Interference Patterning, Nanomaterials, 11, 129.
21. S. Milles, V. Vercillo, S. Alamri, A. I. Aguilar-Morales, T. Kunze, E. Bonaccurso, A. F. Lasagni (2021): Icephobic performance of multi-scale laser-textured aluminum surfaces for aeronautic applications, Nanomaterials, 11, 135.
22. S. Milles, J. Dahms, M. Soldera, A.F. Lasagni (2021): Stable Superhydrophobic Aluminum Surfaces Based on Laser-Fabricated Hierarchical Textures. Materials, 14, 184.
23. R. Baumann, S. Milles, B. Leupolt, S. Kleber, J. Dahms, A.F. Lasagni (2021): Tailored wetting of copper using precise nanosecond direct laser interference patterning, Optics and Lasers in Engineering, 137, 106364.
24. R. Baumann, D. Hipp, A.F. Lasagni, A. Mahrle (2021): Tailored Absorptivity: Increasing the weldability of copper with lasers in the infrared through surface structures, Materials Letters: X, 128700.
25. C. Bischoff, E. Jäger, U. Umhofer, A. F. Lasagni, F. Völklein (2020): Homogeneous intensity within the Rayleigh length and enhanced depth of focus for Gaussian beams, Journal of Laser Micro/Nanoengineering, 15, 3, 178-185.
26. D. Sola, S. Alamnri, A.F. Lasagni (2020): UV Direct Laser Interference Patterning of Diffraction Gratings in Poly-Hydroxyethyl-Methacrylate Ophthalmic Polymers, Journal of Laser Micro/Nanoengineering, 15, 3, 186-190.
27. Y. Fu, M. Soldera, W. Wang, S. Milles, K. Deng, B. Voisiat, K. Nielsch, A. F. Lasagni (2020), Wettability control of polymeric microstructures replicated from laser-patterned stamps, Scientific Reports, 10, 22428 (2020).
28. J. Gebauer, M. Burkhardt, V. Franke, A. F. Lasagni (2020): On the ablation behavior of carbon fiber-reinforced plastics during laser surface treatment using pulsed lasers, Materials, 13, 5682.
29. T. Jähnig, A. F. Lasagni (2020): Laser Interference Patterned ta-C coated dry forming tools, Journal of Industrial Lubrication and Tribology, 72, 8, 1001-1005.
30. N. Schröder, G. Vergara, B. Voisat, A. F. Lasagni (2020): Monitoring the heat accumulation during fabrication of surface micropatterns on metallic surfaces using Direct Laser Interference Patterning, Journal of Laser Micro/Nanoengineering, 15 (2), 150-157.
31. R. Baumann, T. Rauscher, C. I. Bernäcker, C. Zwahr, L. Röntzsch, T. Weißgärber, A. F. Lasagni (2020): Laser structuring of open cell metal foams for micro scale surface enlargement, Journal of Laser Micro/Nanoengineering, 15 (2), 132-138.
32. S. Alamri, V. Vercillo, A. I. Aguilar-Morales, F. Schell, M. Wetterwald, A. F. Lasagni, E. Bonaccurso, T. Kunze (2020): Self-limited Ice Formation and Efficient De-icing on Superhydrophobic Micro-structured Airfoils through Direct Laser Interference Patterning, Advanced Materials Interfaces, 2001231.

33. M. Soldera, F. Fortuna, S. Teutoburg-Weiss, A. F. Lasagni (2020): Comparison of structural colors achieved by laser induced periodic surface structures and direct laser interference patterning, Journal of Laser Micro/Nanoengineering, 15 (2), .97 – 103.
34. M. El-Khoury, B. Voisiat, T. Kunze, A. F. Lasagni (2020): Prediction of optimum process parameters fabricated by direct laser interference patterning based on central composite design, Materials, 13, 4101.
35. A. F. Lasagni, J. Bonse (2020): Laser micro- and nano-material processing – part 2, Advanced Optical Technologies, 9 (3), 111–112.
36. J.T. Cardoso, D. Huerta-Murillo, A.I. Aguilar-Morales, S. Alamri, F.J. Schell, F. Cordovilla, T. Kunze, A.F. Lasagni, J.L. Ocaña (2020): Corrosion resistance of hierarchical laser-structured superhydrophobic aluminium surfaces, Advanced Optical Technologies, 9 (3), 121–130.
37. S. Milles, M. Soldera, T. Kuntze, A.F. Lasagni (2020): Characterization of self-cleaning properties on superhydrophobic aluminum surfaces fabricated by direct laser writing and direct laser interference patterning, Applied Surface Science, 525, 146518.
38. M. Mezera, S. Alamri, W. A.P.M Hendriks, A. Hertwig, A. M. Elert, J. Bonse, T. Kunze, A. F. Lasagni, G.-W. R.B.E. Römer (2020): Hierarchical micro-/nano-structures on Polycarbonate via UV pulsed laser processing, Nanomaterials, 10, 1184, 1-19.
39. S. Alamri, P. A. Sürmann, A. F. Lasagni, T. Kunze (2020): Interference-based Laser-Induced Micro-Plasma Ablation of Glass, Advanced Optical Technologies, 9(1–2), 79–88.
40. J. Bonse, A. F. Lasagni (2020): Laser micro- and nano-material processing – part 1, Advanced Optical Technologies, 9, 1–2, 7–9.
41. F. Kuisat, T. Abraham, T. Schmidt, M. Weber, M. Demmler, G. Bräuer, A. F. Lasagni (2020): Surface Modification of Forming Tools for Aluminum Sheet Metal Forming, Journal of Laser Micro/Nanoengineering, 15, 1, 2020, 19-058.
42. C. Goppold, T. Pinder, S. Schulze, P. Herwig, A. F. Lasagni (2020): Improvement of laser beam fusion cutting of mild and stainless steel due to longitudinal, linear beam oscillation, Applied Science, 2020, 10, 3052
43. F. Mogila, J. Pozo, A.F. Lasagni (2020): Lasers and Surface Functionalization, Photonics Views, 2, 20-22.
44. Vittorio Vercillo, Simone Tonnicchia, Jean-Michel Romano, Antonio García-Girón, Alfredo I. Aguilar-Morales, Sabri Alamri, Stefan S. Dimov, Tim Kunze, Andrés Fabián Lasagni, Elmar Bonaccurso (2020): Design Rules for Laser-Treated Icephobic Metallic Surfaces for Aeronautic Applications, Advanced Functional Materials, 1910268.
45. C. Demuth, A.F. Lasagni (2020): An incompressible smoothed particle hydrodynamics (ISPH) model of direct laser interference patterning, Computation 8, 9, 8010009.
46. B. Voisiat, A.I. Morales, T. Kunze, A.F. Lasagni (2020): Development of an analytical model for optimization of Direct Laser Interference Patterning, Materials 13 (1), 200.
47. M. El-Khoury, S. Alamri, B. Voisiat, T. Kunze, A. F. Lasagni (2020): Fabrication of hierarchical surface textures using multi-pulse Direct Laser Interference Patterning with nanosecond pulses, Materials Letters, 258, 126743.
48. S. Teutoburg-Weiss, B. Voisiat, M. Soldera and A. F. Lasagni (2020): Development of a monitoring strategy for laser textured metallic surfaces using a diffractive approach, Materials 13 (1), 53.
49. M. Soldera, Q. Wang, F. Soldera, V. Lang, A. Abate, A. F. Lasagni (2020): Towards high throughput texturing of polymer foils for enhanced light trapping in flexible perovskite solar cells using roll-to-roll hot embossing, Advanced Engineering Materials, 1901217.

Proceedings and non-peer reviewed papers

1. J. Gebauer, A. F. Lasagni, Improving the bond strength of metal thermal spray deposition on FRP using pulsed laser-based processing approaches, in proceedings of 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, 20.
2. H. J. Langeheinecke, S. Tutunjian, T. Auer, A. F. Lasagni, Online monitoring of an industrial laser-based surface pre-treatment process for aluminium by analyzing the emitted electromagnetic radiations, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, 16.
3. F. R. Ränke, F. Kuisat, F. Lasagni, A. F. Lasagni, Laser-based surface modification of additively manufactured materials components made of Ti64 and Scalmalloy® to influence their wetting behaviour, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, 22.
4. B. Michelberger, D. Jaitner, B. Kröger, A. Leson, A. F. Lasagni, Investigation of different DLIP textured ta-C coated piston rings to analyse and optimise its frictional behaviour, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, 25.
5. M. Seiler, J. Bliedtner, A. F. Lasagni, Laser activation of polymer surfaces, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, 27.
6. J. Zettl, C. Bischoff, S. Runga, C. Esenc, A. F. Lasagni, R. Hellmann (2021), Laser turning using ultra-short laser pulses and intensity distribution techniques, in Proceedings of Lasers in Manufacturing Conference 2021, 183, 1-9.
7. B. Voisiat, M. Menzel, W. Wang, Y. Fu, M. Soldera, A. F. Lasagni (2021), Fabrication of complex periodic patterns on a metallic drum for high throughput roll-to-roll processing, in Proceedings of Lasers in Manufacturing Conference 2021, 126, 1-8.
8. J. Gebauer, V. Franke, K. Gustke, T. Lampke, A. F. Lasagni (2021), Improving the bond strength of metal-FRP-hybrids with thermal sprayed copper using pulsed laser-based processing approaches, in Proceedings of Lasers in Manufacturing Conference 2021, 119, 1-7.
9. M. El-Khoury, M. Seifert, S. Bretschneider, M. Zawischa, T. Steege, S. Alamri, T. Kunze, A. F. Lasagni (2021), Improvement of hardness and wear-resistance of direct laser interference patterned bearing steel surface using laser surface heating approach in Proceedings of Lasers in Manufacturing Conference 2021, 133, 1-5.
10. F. Bouchard, M. Soldera, R. Baumann, A. F. Lasagni (2021), Processing and wetting behavior of hierarchically microstructured polymer foils, in Proceedings of Lasers in Manufacturing Conference 2021, 108, 1-4.
11. Liliana Cangueiro, T. Kiedrowski, N. Schroeder, D. Bruneel, A. F. Lasagni, J. A. Ramos de Campos (2021), Estimating heat accumulation upon ultrafast laser irradiation, in Proceedings of Lasers in Manufacturing Conference 2021, 147, 1-8.
12. A.F. Lasagni, S. Milles, F. Bouchard, R. Baumann, M. Soldera, B. Voisiat (2021), Controlling Surface Properties by Fabricating Single and Multi-Scaled Periodic Surface Structures, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-019, 22.
13. M. El-Khoury, B. Voisiat, T. Kunze, A. F. Lasagni (2021), Optimized Direct Laser Interference Patterning of bearing steel based on response surface methodology, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-022, 32.
14. M. El-Khoury, B. Voisiat, T. Kunze, A. F. Lasagni (2021), Improving throughput and microstructure uniformity in Direct Laser Interference Patterning process utilizing diffractive focus beam shaper, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-023, 33.

15. S. Milles, J. Dahms, M. Soldera, A. F. Lasagni (2021), Fabrication of superhydrophobic hierarchical textures on aluminum by combining laser-based methods, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-019, 24.
16. N. Schröder, S. Teutoburg-Weiss, G. Vergara, A. F. Lasagni (2021), New approach for monitoring a DLIP process using a combination of an infrared camera and a diffraction measurement system, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-037, 16.
17. F. Kuisat, F. Ränke, F. A. Lasagni, A. F. Lasagni (2021), Surface modification of additive manufactured specimens by nanosecond direct laser interference patterning, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-020, 27.
18. F. Kuisat, F. A. Lasagni, A. F. Lasagni (2021), Surface roughness reduction of additive manufactured components by nanosecond pulsed laser treatment, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-030, 29.
19. M. Menzel, B. Voisiat, A. F. Lasagni (2021), Fabrication and Optical Analysis of the Decorative Features Formed by Direct Laser Interference patterning, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-024, 35.
20. S. Milles, V. Vercillo, S. Alamri, A. I. Aguilar-Morales, T. Kunze, E. Bonacursso, A. F. Lasagni (2021), Icephobic micro-textures fabricated by laser-based texturing methods, in proceedings of 22nd International Symposium on Laser Precision Microfabrication, 21-018, 23.
21. K. Gustke, D. Kupke, R. Drehmann, T. Lampke, J. Gebauer, U. Klotzbach, A. F. Lasagni, in Proceedings from the International Thermal Spray Conference, May 2021, DOI: 10.31399/asm.cp.itsc2021p0569
22. T. Kunze, S. Alamri, S. Milles, A.F. Lasagni (2021), The Laser User, 100, 24-25
23. A. F. Lasagni, S. Milles, C. Zwahr (2021): From Single to Multi-scaled Periodic Surface Structure: Towards Multifunctional Surfaces Using Laser Based Microfabrication Methods, in Proceedings of CLEO 2021 (OSA), ATh1R.3, ISBN: 978-1-943580-91-0
24. A. F. Lasagni, S. Milles, F. Bouchard, R. Baumann, B. Voisiat, M. Soldera (2021): Controlling Surface Properties by Fabricating Single and Multi-Scaled Periodic Surface Structures using Laser Based Microfabrication Methods, in Proceedings of CLEO 2021 Europe, 978-1-6654-1876-8
25. A.F. Lasagni, S. Milles, C. Zwahr (2021): From Single to Multi-scaled Periodic Surface Structure: Towards Multifunctional Surfaces Using Laser Based Microfabrication Methods, in Proceedings of CLEO 2021, OSA2121, ATh1R.3.
26. M.C. Araña, R.D. Lahuerta, L.R.X. Cortella, M. Mazzetto, M. Soldera, A. F. Lasagni, I.N. Cestari, I.A. Cestari (2020): Experimental Apparatus for Evaluation of Calcium Fluctuations in Cardiomyocytes Derived from Human-Induced Pluripotent Stem Cells, in Proceedings of XXVII Brazilian Congress on Biomedical Engineering, Vitória, Brazil, 446, ISBN 978-3-030-70600-5.
27. L. R. X. Cortella, I. A. Cestari, A. Y. Kakoi, M. Soldera, A. F. Lasagni, I. N. Cestari (2020): Surface Topography Obtained With High Throughput Technology For hiPSC-derived Cardiomyocyte Conditioning, in Proceedings of XXVII Brazilian Congress on Biomedical Engineering, Vitória, Brazil, 223, ISBN 978-3-030-70600-5.
28. S. Milles, M. Soldera, B. Voisiat, A. F. Lasagni (2020): Multifunctional aluminium surfaces – Laser-structured micropatterns with ice-repellent, superhydrophobic and easy-to-clean properties, ICAA Conference, MATEC Web of Conferences 326, 04005.
29. S. Milles, A. F. Lasagni (2020): Wie mikrostrukturiertes Aluminium eine selbstreinigende Funktion erhält, Der Lebensmittelbrief, 24/7, 12-13.
30. D. Sola, S. Alamri, A. F. Lasagni (2020): Fabrication and characterization of diffraction gratings in ophthalmic polymers by using UV Direct Laser Interference Patterning, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 026, 1-5.

31. S. Alamri, P.A. Sürmann, A. F. Lasagni, T. Kunze (2020): Direct and indirect glass texturing employing interference-based methods, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 111, 1-7.
32. J. Gebauer, A. F. Lasagni, U. Klotzbach (2020): Enhanced joining surfaces by laser processing of fiber-reinforced plastic, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 268, 1-4.
33. M. Soldera, Q. Wang, F. Soldera, V. Lang, A. Abate, A.F. Lasagni (2020): Light absorption enhancement in perovskite solar cells using microstructured polymers imprinted by roll-to-roll hot embossing, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 018, 1-4.
34. R. Baumann, T. Rauscher, C. I. Bernäcker, C. Zwahr, L. Röntzsch, T. Weißgärber, A. F. Lasagni (2020): Laser structuring of open cell metal foams for micro scale surface enlargement, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 034, 1-7.
35. A. Madelung, S. Alamri, A.F. Lasagni, T. Kunze (2020): Upscaling potential and industrial-suitability of scanner-based Direct Laser Interference Patterning, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 053, 1-6.
36. B. Voisiat, S. Milles, A. F. Lasagni (2020): Impact of molten pool dynamics on resultant surface structures during direct laser interference patterning, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 105, 1-6.
37. N. Schröder, G. Vergara, B. Voisat, A. F. Lasagni (2020): Monitoring the heat accumulation during fabrication of surface micropatterns on metallic surfaces using Direct Laser Interference Patterning, in in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 041, 1-8.
38. T. Steege, S. Alamri, A. F. Lasagni, T. Kunze (2020): Process monitoring using photo-acoustic emission in Direct Laser Interference Patterning, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 066, 1-5.
39. S. Milles, M. Soldera, A. F. Lasagni (2020): Quantitative characterization method for assessing the self-cleaning effect on laser microstructured aluminium, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 020, 1-6.
40. S. Alamri, V. Vercillo, A. I. Aguilar-Morales, F. Schell, A.F. Lasagni, E. Bonaccurso, T. Kunze (2020): Interference-based microtexturing for anti-icing and de-icing of a Ti6Al4V NACA airfoil, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 114, 1-6.
41. M. Soldera, Y. Fu, W. Wang, B. Voisiat, A. F. Lasagni (2020): Periodic microstructuring of metal moulds using direct laser interference patterning for nanoimprint replication, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 010, 1-5.
42. M. Soldera, F. Fortuna, S. Teutoburg-Weiss, A. F. Lasagni (2020): Comparison of structural colors achieved by laser induced periodic surface structures and direct laser interference patterning, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 014, 1-7.
43. S. Milles, J. Dahms, B. Voisiat, S. Indrisiunas, G. Račiukaitis, A. F. Lasagni (2020): Wetting properties of the aluminium surface structures fabricated using Direct Laser Interference Patterning with picosecond and femtosecond pulses, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 023, 1-5.
44. B. Voisiat, A. I. Aguilar-Morales, T. Kunze, A. F. Lasagni (2020): Process optimization of Direct Laser Interference Patterning, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 107, 1-5.
45. C. Bischoff, E. Jäger, U. Umhofer, A. F. Lasagni (2020): Homogeneous intensity within the Rayleigh length and enhanced depth of focus for Gaussian beams, in Proceedings of the 21th International Symposium on Laser Precision Microfabrication, 148, 1-7.

46. T. Baselt, C. Taudt, A. K. Virkovski, I. Prade, A. F. Lasagni, Peter Hartmann (2020): Non-disruptive Supercontinuum based scattering analyses of cartilage and collagen before and after apoptosis and necrosis, in Proc. SPIE 11363, Tissue Optics and Photonics, 113630R.
47. V. Lang, A. Madelung, S. Alamri, T. Steege, B. Krupop, A. I. Aguilar, T. Kunze, A. F. Lasagni (2020): High-throughput direct laser interference patterning: new configurations and applications, in Proc. SPIE 11268, Laser-based Micro- and Nanoprocessing XIV, 112680T; doi: 10.1117/12.2541972.
48. B. Voisiat, J. Ströbel, K. Du, A.F. Lasagni (2020): How to improve the throughput of direct laser interference patterning: top-hat beam profile and burst mode, in Proc. SPIE 11268, Laser-based Micro- and Nanoprocessing XIV, 112680Y; doi: 10.1117/12.2547271.
49. T. Jähnig, A. Mousavi, A. Brosius, A.F. Lasagni (2020): Structuring of forming tools for lubricant-free deep drawing, in Proc. SPIE 11268, Laser-based Micro- and Nanoprocessing XIV, 112681O; doi: 10.1117/12.2544731.
50. J.L. Ocaña, D. Huerta-Murillo, A.F. Lasagni, A.I. Aguilar-Morales, S. Alamri, J.T. Cardoso, A. García-Beltrán, F. Cordovilla, I. Angulo (2020): Improvement of metallic surfaces hydrophobicity and corrosion resistance by direct write and combined direct write-DLIP hierarchical micro-nano structuring, in Proc. SPIE 11268, Laser-based Micro- and Nanoprocessing XIV, 112680X; doi: 10.1117/12.2540810.
51. M. Soldera, S. Alamri, S. Storm, T. Kunze, A. F. Lasagni (2020): Maximizing the efficiency of laser-fabricated diffraction gratings on PET using Direct Laser Interference Patterning, in Proc. SPIE 11268, Laser based Micro- and Nanoprocessing XIV, 112680Z; doi: 10.1117/12.2543736.
52. M. Soldera, Y. Fu, F. Fortuna, W. Wang, A.F. Lasagni (2020): Hot embossing of multifunctional transparent polymers from Cr stamps structured by direct laser interference patterning, in Proc. SPIE 11268, Laser-based Micro- and Nanoprocessing XIV, 1126824; doi: 10.1117/12.2546211.
53. M. Soldera, Q. Wang, F. Soldera, V. Lang, A. Abate, A. F. Lasagni, Patterning of transparent polymers using high-throughput methods: application in flexible perovskite solar cells with enhanced light trapping (2020), in Proc. SPIE 11268, Laser-based Micro- and Nanoprocessing XIV, 112680K; doi: 10.1117/12.2543012.
54. T. Baselt, C. Taudt, B. Nelsen, A. F. Lasagni, P. Hartmann (2020): Supermode supercontinuum generation in the cladding of a photonic crystal fiber, in Proc. SPIE 11264, Nonlinear Frequency Generation and Conversion: Materials and Devices XIX, 112641Z; doi: 10.1117/12.2545633.
55. D. Mikhaylov, T. Kiedrowski, A. F. Lasagni: Beam shaping using two spatial light modulators for ultrashort pulse laser ablation of metals (2020), in Proc. SPIE 10906, Laser-based Micro- and Nanoprocessing XIII, 1090615; doi: 10.1117/12.2508682.

Presentations/Conference contributions

1. A.F. Lasagni, Direct laser interference patterning: a tool for large area functionalisation of surfaces, Laser Symposium / ISAM 2021 conference, December 2021, Webinar (invited).
2. A.F. Lasagni, S. Milles: An overview of laser-based functionalization of surfaces, ESTAL 2021 Conference, October 2021, Webinar (invited).
3. A.F. Lasagni, LAMPAS: Surface enhancements inspired by nature, European Photonics Manufacturing Services Funded by EC, June 2021, Webinar (invited).
4. A.F. Lasagni, S. Milles, F. Bouchard, R. Baumann, B. Voisiat, M. Soldera, Controlling Surface Properties by Fabricating Single and Multi-Scaled Periodic Surface Structures using Laser Based Microfabrication Methods, CLEO EUROPE 2021, webinar (invited).
5. A. F. Lasagni, Oberflächenfunktionalisierung durch laserbasierte Methoden der Mikroproduktion, LEF Bricks, June 2021, Webinar (invited).

6. A.F. Lasagni, S. Milles, F. Bouchard, R. Baumann, M. Soldera, B. Voisiat, Controlling Surface Properties by Fabricating Single and Multi-Scaled Periodic Surface Structures, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (invited).
7. A.F. Lasagni, S. Milles, C. Zwahr, From Single to Multi-scaled Periodic Surface Structure: Towards Multifunctional Surfaces Using Laser Based Microfabrication Methods, CLEO2021 (OSA 2021), USA, May 2021 (invited).
8. A.F. Lasagni, Fabricación de superficies funcionales utilizando tecnologías laser, XXII Congreso Argentino de Fisicoquímica y Química Inorgánica, April 2021, La Plata, Argentina (plenary talk).
9. F. Ränke, F. Kuisat, R. Baumann, F. A. Lasagni, A. F. Lasagni, Fabrication of water and ice-repellent surfaces on additive manufactured parts using laser-based microstructuring methods, Laser Symposium & ISAM 2021, December 2021, Webinar (online).
10. M. Seiler, A. Barz, A.F. Lasagni, J. Bliedtner, Process window for selective metallization of PC with picosecond laser radiation, Laser Symposium & ISAM 2021, December 2021, Webinar (online).
11. S. Moghtaderifard, M. Soldera, A.F. Lasagni, Modelling and validation of microstructure replication on aluminum foils from laser-patterned stamps, Laser Symposium & ISAM 2021, December 2021, Webinar (online).
12. T. Steege, Predictive modelling of laser-induced functional surface textures through machine learning, Laser Symposium & ISAM 2021 conference, December 2021, Webinar (online).
13. F. Kuisat, F. Ränke, F. Lasagni, A.F. Lasagni, Laserbasierte Oberflächenmodifikation von additiv gefertigtem Ti64 und deren Auswirkungen auf die Topographie und das Benetzungsverhalten, Gemeinschaftssitzung der DGM-Fachausschüsse Funktionalisierung von Oberflächen mittels Mikro-/Nano- Strukturierungsverfahren und Biomaterialien, November 2021, Germany (online).
14. L. Mulko, A. F. Lasagni, Laser-patterned nanocomposites with external triggering topography based on polymeric hydrogels surfaces with applications in photothermal therapy and advanced wound dressings, , Gemeinschaftssitzung der DGM-Fachausschüsse Funktionali-sierung von Oberflächen mittels Mikro-/Nano- Strukturierungsverfahren und Biomaterialien, November 2021, Germany (online).
15. M. Soldera, S. Moghtaderifard, A.F. Lasagni, Replicación de microestructuras en láminas de aluminio utilizando estampas procesadas por láser, III. Simposio de la RCAA, November 2021 (online).
16. L.E. Mulko, R. Bauman, M. Soldera, A.F. Lasagni, On-demand polymer-based anisotropic conductive scaffolds generated by direct laser microprocessing, III. Simposio de la RCAA, November 2021 (online)
17. A.F. Lasagni, S. Milles, C. Zwahr, Functionalization of surfaces by fabricating single and multi-scaled periodic structures using laser based fabrication methods, EUROMAT 2021, September 2021, Graz, Austria (online).
18. M. Soldera, S. Alamnri, P. Alexander, T. Kunze, A.F. Lasagni, Surface functionalization of soda-lime glass by interference-based laser direct nano/microstructuring, EUROMAT 2021, September 2021, Graz, Austria (online).
19. M. Soldera, R. Baumann, W. Wang, A.F. Lasagni, Microstructuring of periodic grooves on ITO-coated glass by femtosecond direct laser interference patterning, EUROMAT 2021, September 2021, Graz, Austria (online).
20. M. Soldera, Y. Fu, W. Wang, S. Milles, K. Deng, K. Nielsch, A.F. Lasagni, Micropatterned polymeric foils with increased hydrophobicity replicated from laser-textured molds, EUROMAT 2021, September 2021, Graz, Austria (online).

21. M. Mezera, A.F. Lasagni, S. Alamri, W. Hendriks, A. Hertwig, A. M. Elert, J. Bonse, T. Kunze, G.-w. R.B.E. Römer, Fabrication of Hierarchical Micro-/Nano-Structures on Polycarbonate using UV Laser Based Processing Methods, EUROMAT 2021, September 2021, Graz, Austria (online).
22. L. Lorenz, F. Härtwig, S. Makowski, V. Weihnacht, C. M. Krause, A. F. Lasagni, Triboscopy as a Quasi-In-Situ Technique for Dry Friction of ta-C Coatings in Vacuum and Ambient Air Conditions, EUROMAT 2021, September 2021, Graz, Austria (online).
23. D. Sola, S. Milles, A. F. Lasagni, Fabrication and hydration assessment of diffraction gratings in ophthalmic polymers by Direct Laser Interference Patterning, EUROMAT 2021, September 2021, Graz, Austria (online).
24. B. Michelberger, D. Jaitner, B. Kröger, A.F. Lasagni, Combined measurement and simulation of piston ring liner contacts with a reciprocating long-stroke tribometer, EUROMAT 2021, September 2021, Graz, Austria (online).
25. F. Schell, S. Alamri, A. Gebert, A. Hariharan, T. Kunze, A.F. Lasagni, Multiscale microtexturing of additive-manufactured titanium alloy for increased osseointegration, Materials Week, September 2021, Germany (online).
26. L. Mulko, D. Acevedo, S. Bongiovanni, S. Marcos, R. Robert, A.F. Lasagni, Towards the design and development of neural scaffolds based on conductive polymers by direct laser interference modelling, Materials Week, September 2021, Germany (online).
27. L. Mulko, R. Baumann, E. Jaeger, M. Soldera, W. Wang, A.F. Lasagni, Multiphoton fabrication of polymeric structures using picosecond and femtosecond laser interference processing, Materials Week, September 2021, Germany (online).
28. B. Henriques, B. Voisiat, A. F. Lasagni, Direct Laser Interference Patterning of zirconia surfaces, XIX Brazil MRS Meeting, September 2021, Brazil (online).
29. A.F. Lasagni, N. Schröder, S. Teutoburg-Weiss, High-throughput laser processing, real-time monitoring and functionalization of surfaces using Direct Laser Interference Patterning, XIX Brazil MRS Meeting, September 2021, Brazil (online).
30. J. Gebauer, A. F. Lasagni, Improving the bond strength of metal thermal spray deposition on FRP using pulsed laser-based processing approaches, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, online conference, Dresden, Germany (online).
31. H. J. Langeheinecke, S. Tutunjian, T. Auer, A. F. Lasagni, Online monitoring of an industrial laser-based surface pre-treatment process for aluminium by analyzing the emitted electromagnetic radiations, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, online conference, Dresden, Germany (online).
32. F. R. Ränke, F. Kuisat, F. Lasagni, A. F. Lasagni, Laser-based surface modification of additively manufactured materials components made of Ti64 and Scalmalloy® to influence their wetting behaviour, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, online conference, Dresden, Germany (online).
33. B. Michelberger, D. Jaitner, B. Kröger, A. Leson, A. F. Lasagni, Investigation of different DLIP textured ta-C coated piston rings to analyse and optimise its frictional behaviour, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, online conference, Dresden, Germany (online).
34. M. Seiler, J. Bliedtner, A. F. Lasagni, Laser activation of polymer surfaces, 10th International Summer School Trends and new developments in Laser Technology 2021, August 2021, online conference, Dresden, Germany (online).
35. M. Kovačič, F. Bouchard, M. Soldera, A.F. Lasagni, D. Samigullina, J. Krč, S. Lenk, B. Lipovšek, S. Reineke and M. Topič, Light Management Foils with Hierarchical Textures for Light Outcoupling in

OLEDs, Optical Devices and Materials for Solar Energy and Solid-state Lighting 2021, July 2021, Washington DC, United States.

36. J. Zettl, C. Bischoff, S. Runga, C. Esenc, A. F. Lasagni, R. Hellmann, Laser turning using ultra-short laser pulses and intensity distribution techniques, Lasers in Manufacturing 2021, June 2021, Munich, Germany (online).
37. F. Bouchard, M. Soldera, R. Baumann, A. F. Lasagni, Processing and wetting behavior of microstructured polymer foils, Lasers in Manufacturing 2021, June 2021, Munich, Germany (online).
38. J. Gebauer, V. Franke, K. Gustke, U. Klotzbach, T. Lampke, A.F. Lasagni, Improving the bond strength of Metal-FRP-Hybrids with thermal sprayed Copper using pulsed laser-based processing approaches, Lasers in Manufacturing 2021, June 2021, Munich, Germany (online).
39. B. Voisiat, M. Menzel, W. Wang, Y. Fu, M. Soldera, A.F. Lasagni, Fabrication of complex periodic patterns on a metallic drum for high throughput roll-to-roll processing, Lasers in Manufacturing 2021, June 2021, Munich, Germany (online).
40. M. El-Khoury, M. Seifert, S. Bretschneider, M. Zawischa, T. Kunze, A.F. Lasagni, Improvement of hardness and wear-resistance of direct laser interference patterned bearing steel surface using laser surface heating approach, Lasers in Manufacturing 2021, June 2021, Munich, Germany (online).
41. L. Cangueiro, T. Kiedrowski, N. Schroeder, D. Bruneel, A.F. Lasagni, J.A. Ramos-de-Campos, Estimating heat accumulation upon ultrafast laser irradiation, Lasers in Manufacturing 2021, June 2021, Munich, Germany (online).
42. M. El-Khoury, B. Voisiat, T. Kunze, A. F. Lasagni, Optimized Direct Laser Interference Patterning of bearing steel based on response surface methodology, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (online).
43. M. El-Khoury, B. Voisiat, T. Kunze, A. F. Lasagni, Improving throughput and microstructure uniformity in Direct Laser Interference Patterning process utilizing diffractive focus beam shaper, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (online).
44. N. Schröder, S. Teutoburg-Weiss, G. Vergara, A. F. Lasagni, New approach for monitoring a DLIP process using a combination of an infrared camera and a diffraction measurement system, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (online).
45. F. Kuisat, F. Ränke, F. A. Lasagni, A. F. Lasagni, Surface modification of additive manufactured specimens by nanosecond direct laser interference patterning, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (online).
46. F. Kuisat, F. A. Lasagni, A. F. Lasagni, Surface roughness reduction of additive manufactured components by nanosecond pulsed laser treatment, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (online).
47. M. Menzel, B. Voisiat, A. F. Lasagni, Fabrication and Optical Analysis of the Decorative Features Formed by Direct Laser Interference patterning, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (online).
48. S. Milles, V. Vercillo, S. Alamri, A. I. Aguilar-Morales, T. Kunze, E. Bonacursso, A. F. Lasagni, Icephobic micro-textures fabricated by laser-based texturing methods, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar (online).
49. S. Milles, J. Dahms, M. Soldera, A. F. Lasagni. Fabrication of superhydrophobic hierarchical textures on Aluminum by combining laser-based methods, 22nd International Symposium on Laser Precision Microfabrication, June 2021, Webinar.
50. L. E. Mulko, S. Bongiovanni, M. Soldera, F. Bouchard, D. Acevedo, A.F. Lasagni, On the design of structured scaffolds using conducting polymers by direct laser interference patterning, XXII

Congreso Argentino de Fisicoquímica y Química Inorgánica (CAFQI2021), April 2021, virtual conference, La Plata, Argentina (online).

51. T. Steege, S. Alamri, A.F. Lasagni, U. Klotzbach, T. Kunze, Detection and analysis of airborne acoustic signals in direct laser interference patterning, SPIE Photonics West, February 2021, San Francisco, USA, 11674-2 (online).
52. M. Wieczorek, A. Philipp, A. F. Lasagni, Patterning organic light-emitting diodes via passivation and ultra-short pulsed laser ablation, LOPEC 2021 – printed (opto) electronic devices II, March 2021.
53. A.F. Lasagni, F. Mücklich: Wieso erlauben mikrostrukturierte Oberflächen vielfältige disruptive Innovationen?, Sitzung des Themennetzwerks Materialwissenschaft & Werkstofftechnik, November 2020, ACATECH (invited).
54. A.F. Lasagni: Interferencia de laser directa: un método industrial para la funcionalización de superficies, Instituto Nacional de Tecnología Agropecuaria, Red INTA October 2020, REC NanoBiom (plenary talk).
55. A.F. Lasagni: Pequeños pasos, grandes recompensas, Ciclo de conferencias "Curso Formación de Líderes", October 2020, Buenos Aires (web) (invited).
56. A.F. Lasagni: Direct Laser Interference Patterning: new ideas and concepts for high-throughput processing, AILU conference Applications for Micro and Nano Material Processing with Lasers, October 2020 (invited).
57. A.F. Lasagni: Fabricación de superficies funcionales utilizando tecnologías laser, Fundación Argentina de Nanotecnología, ciclo online de divulgación nano, September 2020 (plenary talk).
58. A.F. Lasagni: the LAMpAS project, EPIC Online Technology Meeting on Surface Disinfection and Antibacterial Surfaces, August 2020 (invited).
59. M. Soldera, A.F. Lasagni, Modificación de propiedades ópticas superficiales mediante métodos basados en interferencia láser, RCAA Annual Meeting, online, November 2020, Germany.
60. M. Soldera, A.F. Lasagni, Modification of surface optical properties using laser-based methods for decorative, anti-counterfeiting and electronic applications, DGM worshop Functionalisation of surfaces by micro- and nano patterning techniques, November 2020, online, Germany.
61. V. Vercillo, S. Alamri, A. I. Aguilar-Morales, T. Kunze, E. Bonaccurso, A.F. Lasagni, Laser Surface Micro-/nano-structuring to Produce Icephobic Properties for Aerospace Applications, DGM worshop Functionalisation of surfaces by micro- and nano patterning techniques, November 2020, online, Germany.
62. S. Milles, M. Soldera, B. Voisiat, A. F. Lasagni, Multifunctional aluminium surfaces – Laser-structured micropatterns with ice-repellent, superhydrophobic and easy-to-clean properties, 17th International Conference on Aluminium Alloys (ICAA2020), October 2020, online-conference, Grenoble, France
63. B. Henriques, B. Voisiat, A. F. Lasagni, Direct Laser Interference Patterning of biomedical zirconia using Picosecond Pulsed Laser: Effect of laser processing parameters on the surface topography, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
64. J. Gebauer, M. Burkhardt, V. Franke, U. Klotzbach, A. F. Lasagni, Ablation behavior of fiber-reinforced plastic treated by pulsed lasers, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
65. D. Sola, S. Alamri, S. Milles, A. F. Lasagni, Fabrication and hydration assessment of diffraction gratings in ophthalmic polymers by Direct Laser Interference Patterning, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
66. A. F. Lasagni, V. Lang, A. Madelung, S. Alamri, B. Voisiat, A. Aguilar, T. Kunze, B. Krupop, T. Steege: Going faster and faster: how Direct Laser Interference Patterning method can be used for high-

throughput functionalization of surfaces, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.

67. B. Voisiat, S. Milles, A. F. Lasagni, Molten pool dynamics effects in the fabrication of microstructures by Direct Laser Interference Patterning, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
68. S. Alamri, V. Vercillo, A. I. Aguilar-Morales, F. Schell, A. F. Lasagni, E. Bonaccurso, T. Kunze, Enhanced anti-icing and de-icing of a titanium airfoil through Direct Laser Interference Patterning, , Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
69. M. El-Khoury, T. Kunze, B. Voisiat, A. F. Lasagni, Optimization of Direct Laser Interference Process using design of experiments approach, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
70. B. Voisiat, A. I. Aguilar-Morales, T. Kunze, A. F. Lasagni, Analytical prediction model for Direct Laser Interference Patterning, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
71. F. Kuisat, F. Lasagni, A. F. Lasagni, Smoothing of additive manufactured parts using ns-pulsed laser source, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
72. F. Kuisat, F. Ränke, F. Lasagni, A. F. Lasagni, Surface macro-smoothing and micro-structuring of additive manufactured components by using DLIP technique for controlling wetting characteristics, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
73. M El-Khoury, B. Voisiat, A. F. Lasagni, Top-Hat profile in Direct Laser Interference Patterning: Is it worth it?, Materials Science & Engineering, September 2020, online-conference, September 2020, Germany.
74. M.C. Araña, R.D. Lahuerta, L.R.X. Cortella, M. Mazzetto, M. Soldera, A. F. Lasagni, I.N. Cestari, I.A. Cestari, Experimental Apparatus for Evaluation of Calcium Fluctuations in Cardiomyocytes Derived from Human-Induced Pluripotent Stem Cells, XXVII Congresso Brasileiro de Engenharia Biomédica, September 2020, Universidade Federal do Espírito Santo, Brazil.
75. L. R. X. Cortella, I. A. Cestari, A. Y. Kakoi, M. Soldera, A. F. Lasagni, I. N. Cestari, Surface Topography Obtained With High Throughput Technology For hiPSC-derived Cardiomyocyte Conditioning, XXVII Congresso Brasileiro de Engenharia Biomédica, September 2020, Universidade Federal do Espírito Santo, Brazil.
76. M. Soldera, Q. Wang, F. Soldera, V. Lang, A. Abate, A. F. Lasagni, Light management in flexible perovskite solar cells achieved by Direct Laser Interference Patterning and Roll-to-Roll hot embossing, 9th International Summer School Trends and new developments in Laser Technology 2020, August 2020, online conference, Dresden, Germany.
77. W. Wang, Y. Fu, M. Soldera, A. F. Lasagni, Fabrication of hierarchical microstructures by means of Direct Laser Interference Patterning (DLIP) and Nanoimprinting Lithography (NIL), 9th International Summer School Trends and new developments in Laser Technology 2020, August 2020, online conference, Dresden, Germany.
78. D. Sola, S. Alamri, A. F. Lasagni, A. F. Lasagni, Fabrication and characterization of diffraction gratings in ophthalmic polymers by using UV Direct Laser Interference Patterning, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
79. A. F. Lasagni, D. Bauer, T. Kiedrowski, F. Moglia, L. Penning, G. Vergara, A. Villate, J. A. Ramos de Campos, R. Baumann, N. Schröder, D. Sutter, D. Bruneel, R. De Loor, A. Ripoll, High throughput Laser structuring with Multiscale Periodic feature sizes for Advanced Surface Functionalities

(LAMpAS), 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.

80. S. Alamri, P.A. Sürmann, A. F. Lasagni, T. Kunze, Direct and indirect glass texturing employing interference-based methods, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
81. J. Gebauer, A. F. Lasagni, U. Klotzbach, Enhanced joining surfaces by laser processing of fiber-reinforced plastic, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
82. M. Soldera, Q. Wang, F. Soldera, V. Lang, A. Abate, A.F. Lasagni, Light absorption enhancement in perovskite solar cells using microstructured polymers imprinted by roll-to-roll hot embossing, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
83. R. Baumann, T. Rauscher, C. I. Bernäcker, C. Zwahr, L. Röntzsch, T. Weißgärber, A. F. Lasagni, Laser structuring of open cell metal foams for micro scale surface enlargement, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
84. A. Madelung, S. Alamri, A.F. Lasagni, T. Kunze, Upscaling potential and industrial-suitability of scanner-based Direct Laser Interference Patterning, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
85. B. Voisiat, S. Milles, A. F. Lasagni, Impact of molten pool dynamics on resultant surface structures during direct laser interference patterning, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
86. N. Schröder, G. Vergara, B. Voisat, A. F. Lasagni, Monitoring the heat accumulation during fabrication of surface micropatterns on metallic surfaces using Direct Laser Interference Patterning, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
87. T. Steege, S. Alamri, A. F. Lasagni, T. Kunze, Process monitoring using photo-acoustic emission in Direct Laser Interference Patterning, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
88. S. Milles, M. Soldera, A. F. Lasagni, Quantitative characterization method for assessing the self-cleaning effect on laser microstructured aluminium, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
89. S. Alamri, V. Vercillo, A. I. Aguilar-Morales, F. Schell Prof. Dr. Andrés F. Lasagni Dr. Elmar Bonaccurso Dr. Tim Kunze, Interference-based microtexturing for anti-icing and de-icing of a Ti6Al4V NACA airfoil, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
90. M. Soldera, Y. Fu, W. Wang, B. Voisiat, A. F. Lasagni, Periodic microstructuring of metal moulds using direct laser interference patterning for nanoimprint replication, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
91. M. Soldera, F. Fortuna, S. Teutoburg-Weiss, A. F. Lasagni, Comparison of structural colors achieved by laser induced periodic surface structures and direct laser interference patterning, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
92. S. Milles, B. Voisiat, A. F. Lasagni, Comparison of picosecond and femtosecond pulsed four-beam direct laser interference patterning on pure aluminum, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.
93. B. Voisiat, A. I. Aguilar-Morales, T. Kunze, A. F. Lasagni, Process optimization of Direct Laser Interference Patterning, 21st International Symposium on Laser Precision Microfabrication, June 2020, Webinar.

94. C. Bischoff, E. Jäger, U. Umhofer, A. F. Lasagni, Homogeneous intensity within the Rayleigh length and enhanced depth of focus for Gaussian beams, 9th International Congress on Laser Advanced Materials Processing, June 2020, Webinar.
95. M. Soldera, Q. Wang, F. Soldera, V. Lang, A. Abate, A. F. Lasagni, Polymeric substrates structured by roll-to-roll nano-imprint lithography for flexible perovskite solar cells with improved light management, 12th Conference on Hybrid and Organic Photovoltaics (HOPV20), May 2020, Online Conference, Spain
96. V. Lang, A. Madelung, S. Alamri, T. Steege, B. Krupop, A. I. Aguilar, T. Kunze, A. F. Lasagni, High-throughput direct laser interference patterning: new configurations and applications, SPIE Photonics West, February 2020, San Francisco, USA.
97. B. Voisiat, J. Ströbel, K. Du, A.F. Lasagni, How to improve the throughput of direct laser interference patterning: top-hat beam profile and burst mode, SPIE Photonics West, February 2020, San Francisco, USA.
98. T. Jähnig, A. Mousavi, A. Brosius, A.F. Lasagni, Structuring of forming tools for lubricant-free deep drawing, SPIE Photonics West, February 2020, San Francisco, USA.
99. J.L. Ocaña, D. Huerta-Murillo, A.F. Lasagni, A.I. Aguilar-Morales, S. Alamri, J.T. Cardoso, A. García-Beltrán, F. Cordovilla, I. Angulo, Improvement of metallic surfaces hydrophobicity and corrosion resistance by direct write and combined direct write-DLIP hierarchical micro-nano structuring, SPIE Photonics West, February 2020, San Francisco, USA.
100. M. Soldera, S. Alamri, S. Storm, T. Kunze, A. F. Lasagni, Maximizing the efficiency of laser-fabricated diffraction gratings on PET using Direct Laser Interference Patterning, SPIE Photonics West, February 2020, San Francisco, USA.
101. M. Soldera, Y. Fu, F. Fortuna, W. Wang, A.F. Lasagni, Hot embossing of multifunctional transparent polymers from Cr stamps structured by direct laser interference patterning, SPIE Photonics West, February 2020, San Francisco, USA.
102. M. Soldera, Q. Wang, F. Soldera, V. Lang, A. Abate, A. F. Lasagni, Patterning of transparent polymers using high-throughput methods: application in flexible perovskite solar cells with enhanced light trapping, SPIE Photonics West, February 2020, San Francisco, USA.
103. T. Baselt, C. Taudt, B. Nelsen, A. F. Lasagni, P. Hartmann, Supermode supercontinuum generation in the cladding of a photonic crystal fiber, SPIE Photonics West, February 2020, San Francisco, USA.
104. S. Milles, R. Baumann, J. Dahms, A. F. Lasagni, Large area processing of steel surfaces using Direct Laser Interference Patterning, SPIE Photonics West, February 2020, San Francisco, USA.
105. T. Jähnig, M. El-Khoury, A.F. Lasagni, Lubricant-free metal forming – Friction reduction by laser structuring ta-C coated forming tools, 22nd International Colloquium of Tribology, January 2020, Esslingen, Germany.

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