

Hub of Application Laboratories for Equipment
Assessment in Laser Based Manufacturing

Editorial

Dear APPOLO newsletter
readers,



In February, one of the biggest events related to laser - the Photonics West exhibition and related conferences - passed in San Francisco with active participation of APPOLO partners. On this occasion, I visited one of our customers in Silicon valley and found a suitable quote of the economic guru Theodore Levitt: *"People don't want to buy a quarter-inch drill, they want a quarter-inch hole."* Directly related to our goals within the APPOLO project, we do not aim at developing the best and most reliable laser or scanner, but validating processes to finally produce goods for everyday live: cars, energy and consumers.

The APPOLO project entered its last six months of implementation. After intensive assessment experiments initially planned in the project and finished in the third year, the upcoming period is calmer. Most of the initial assessment experiments were successfully finished and evaluated by the reviewers. Shifting to new perspectives, perovskite solar cells extended their activities in laser process development for their kind of thin film solar cells. Fast, precise and efficient laser surface texturing seems to be an endless job for new technologies and applications. The final deliverable on advanced polygon scanners permitted entry to the final assessment within APPOLO project. A summary of the activities will be reviewed in a special session during the LPM2017 conference in Japan and summer school in Vilnius.

3D mould texturing methods were assessed and optimised for applications on automotive interior components, offering innovative surfaces with tuneable glare and haptic properties, not possible with conventional (laser) engraving based texturing. The visual appearance of the surfaces was improved and finally resulted in a perfectly homogeneous texture, enabled by a random dimple distribution on the surface. However the requirements for automotive applications are very tough. Especially the demand for high wear resistance of the textured polymer surfaces could not be met completely. Nevertheless APPOLO developments resulted in a technology already gaining acceptance in other industries already.

The comparative cost analysis shows clear benefits of the APPOLO technologies developed during the assessment of lasers for selective electroless metallization. Notably better performance was found in the new SSAIL technology, where polymers without additives are used.

The APPOLO Summer School in Vilnius will be one of the final events, spreading knowledge and expertise from world-leading scientists and APPOLO experts to young generation.

We hope you enjoy this edition of the APPOLO newsletter,
Gediminas Račiukaitis, Project Coordinator

In this Issue

■ Editorial	1
■ Focus Topic – About APPOLO	2
■ Meet the Consortium	6
■ SCANLAB	6
■ LIGHTMOTIF	8
■ IT4IP	9
■ Upcoming Events	11
■ The Consortium	13
■ Contacts	13

www.appolo-fp7.eu

Focus Topic

Laser-induced selective metallization of polypropylene doped with multiwall carbon nanotubes

**Center for Physical Sciences and Technology,
Centro Ricerche Fiat, BioAge Srl,**

Moulded interconnect devices (MID) offer material, weight and cost saving by integration electronic circuits directly into polymeric components used in automotive and other consumer products. Lasers are used to write circuits directly on polymers by modifying their surface followed by an electroless metal plating. There are several techniques of laser writing for selective plating of polymers. Laser direct structuring (LDS) is the method using precursors mixed in a polymer matrix. These precursor additives are activated during the laser writing process in order to become a catalyst for electroless deposition of the metal, and thus the laser-scanned area can be selectively plated. There are a few commercial materials for LDS available on the market, but most of them are based on expensive metal-organic fillers, usually including palladium.

Two new approaches were successfully developed and validated in the APPOLO project.

Laser direct structuring of polymers with carbon additives

A new composite material – polypropylene doped with multiwall carbon nanotubes - was developed for the laser-induced selective metallization. Mechanisms of surface activation by laser irradiation were investigated in detail, utilising pico- and nanoseconds lasers. The deposition of copper was performed in the autocatalytic electroless plating bath. The laser-activated polymer surfaces have been studied using the Raman spectroscopy and scanning electron microscope (SEM). Microscopic images revealed that surfaces only become active after being melted by a laser. Alterations in the Raman spectra indicated the clustering of carbon additives in the composite material. Optimal laser parameters for the surface activation were found by measuring sheet resistances of the finally

metal-plated samples. Spatially selective copper plating was achieved with the smallest conductor line width of 22 μm at the laser scanning speed of 3 m/s and a pulse repetition rate of 100 kHz. Finally, the technique was validated by producing functional electronic circuits.

All measurements were combined and presented as the sheet conductance in dependence of the irradiation dose (Fig.1). Although the same equivalent irradiation dose values were calculated from different parameter sets of laser processing (scanning speed and laser power), the samples processed at those regimes exhibited similar values of the sheet conductance. The results indicate that the laser-activation of the polymer surface has to pass a certain threshold. The drastic increase in the sheet conductance started at the dose of 0.55 J/cm^2 and stabilised at the high ($\text{S}\cdot\text{sq}$) value when the irradiation dose was higher than 1.4 J/cm^2 . SEM pictures revealed the melting of the polymer surface when the irradiation dose passed the threshold.

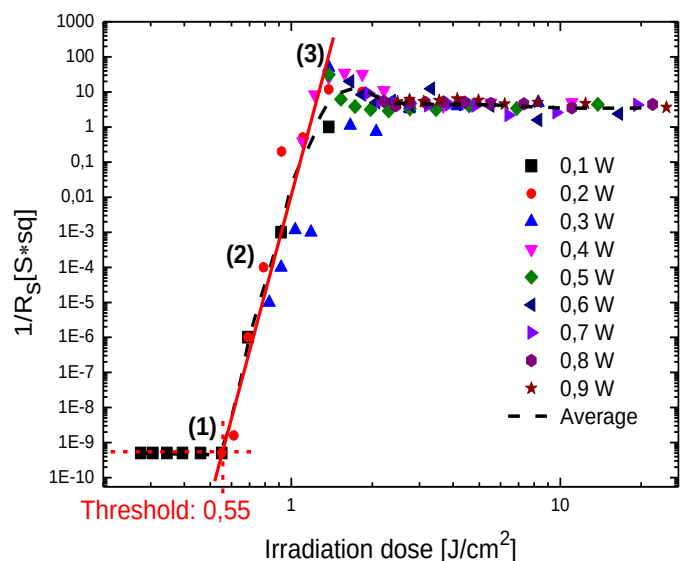


Fig. 1. Dependence of the sheet conductance on the irradiation dose. Laser radiation wavelength was 1064 nm. ©FTMC

Selectivity of metal plating was tested by varying diameters of the laser beam affecting the polymer surface. A precise control of the line width was performed by adjusting the defocusing distance. The width of the line from 22 μm to more than 100 μm was achieved in a single laser scan without hatching as shown in Fig. 2.

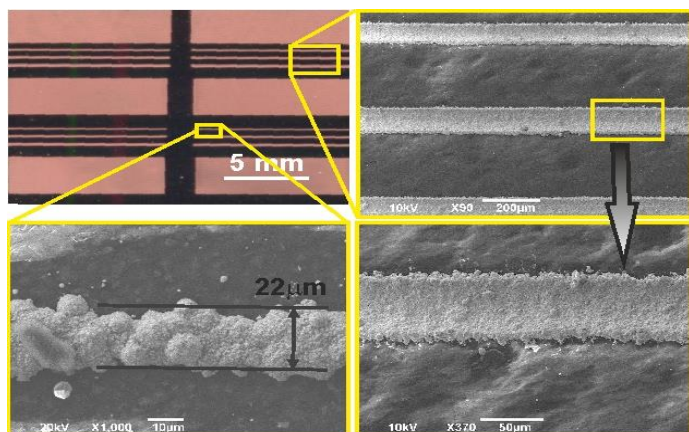


Fig. 2. Results of the spatial selectivity test of plating by changing the focus position. © FTMC

Finally, the new PP-MWCNT material with the laser surface activation approach was applied for the production of functioning electronic circuit prototypes. Moulded interconnected device trials for FIAT 500 gloves box cover were prepared. The electronic circuit layout of the touch button for the cover opening mechanism was fabricated using the PP-MWCNT material and LDS process.

Selective surface activation induced by laser (SSAIL-method)

A completely new laser-induced selective metallisation technology has been developed at FTMC. For SSAIL, PC/ABS polymer was used as a substrate. No LDS additives are needed for the activation process. The process contains 4 steps: 1) Surface treatment with picosecond laser; 2) Chemical activation of treated areas in low concentration palladium-free solution; 3) Rinsing – the step is necessary to wash away adhered activator molecules from untreated surface areas; 4) and finally plating in electroless copper plating bath (the same as used in LDS experiments). The method allows the achievement of high spatial selectiveness at 3 m/s scanning speed.

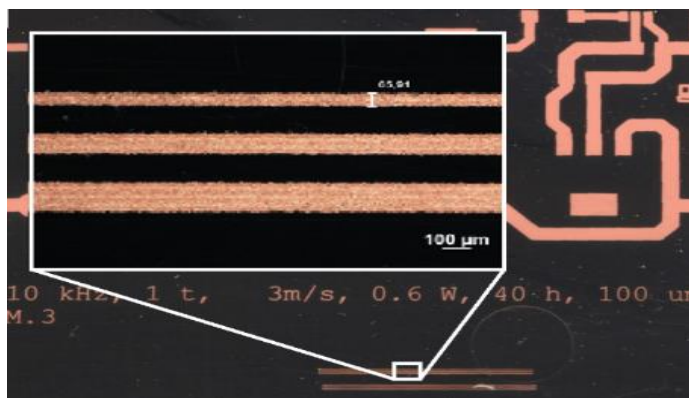


Fig. 3: Spatial selectiveness of metallisation using the SSAIL method at 3 m/s scanning speed. ©FTMC

The sheet resistance of plated samples has been measured in order to evaluate various sets of laser parameters, such as scanning speed, pulse repetition rate and wavelength used for activation. The results also indicated threshold behaviour in dependence of the irradiation dose.

All samples were electroless plated initially with copper. Optimal plating bath conditions were estimated: composition, the concentration of components, temperature, plating time. The glove cover box samples coated with copper and copper and silver are shown below.

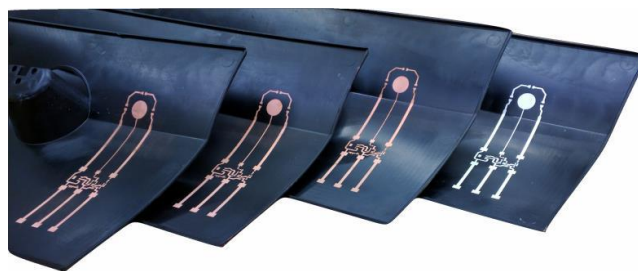


Fig. 4: Glove box cover samples coated with copper and copper + silver © FTMC

The adhesion of coatings for copper and copper + silver layers has been checked with the scotch tape test. Determined results indicate perfect adhesion for PC/ABS. All samples passed the test.

Evaluation of the processing costs

All the selective plated samples have been successfully assembled to manufacture the two final demonstrator products: automotive glove box and temperature sensor. The processing cost evaluation has been drawn up to compare the two new APPOLO technologies with existing LDS.

The comparative cost analysis shows clear benefits of the technologies developed during the APPOLO assessment of laser for selective electroless metallization. The initial approach of using polymers with carbon additives allows the reduction of metallization related cost by half in comparison to the conventional LDS technology, using metal additives. LDS with carbon additives works well with nanosecond lasers. The significantly better performance was found in SSAIL technology, where polymers without additives are used, but only picosecond lasers can give the required polymer surface excitation.

Two patent applications were submitted by FTMC for those technologies and various approaches to foster an efficient commercialization are under discussion among the partners.

Table 1. Process cost comparison for conventional LDS, LDS for polymers with carbon additives and SSAIL laser-based selective metallization technologies for MID.

Method	LDS	LDS	SSAIL
	standard on market	APPOLO carbon	APPOLO pure
Equipment	Nanosecond laser	Nanosecond laser	Picosecond laser
Cost of laser	40 k€	40 k€	150 k€
Other equipment	150 k€	150 k€	150 k€
Cost of whole laser processing machine	190 k€	190 k€	300 k€
Laser processing expenses /s (equipment cost*time/20 K hour)	0,0026 €	0,0026 €	0,0042 €
Plastic	PC/ABS with metalo-organic additives	PC/ABS + 2% MWCNT	PC/ABS
Appr. cost of plastic /kg	2,00 €	2,00 €	2,00 €
Appr. cost of additive to plastic /kg	6,00 €	1,40 €	0,00 €
Chemical activation solution, /l	0,00 €	0,00 €	0,22 €
Cost of chemical process /100 cm ²	0,11 €	0,11 €	0,15 €
Cost of laser processing /100 cm ²	0,1758 €	0,1758 €	0,2775 €
Processing expenses for a glove box cover	3,2501 €	1,4495 €	0,9327 €

* Expenses, excluded the cost of injection moulding, as it is equivalent to all methods.

APPOLO Summer School from 3-7th of July

The FTMC has announced the date for this year's APPOLO Summer School on Ultra-short Pulse Lasers Applications in Material Processing. From the July 3rd until 7th APPOLO encourages every enthusiastic student and young researcher working in the field of material processing to participate in this international school full of great invited speakers and exciting excursions. The participation fee is 100 €.

For more Information please visit <http://uplamp.ftmc.lt/> or contact conference@ftmc.lt

Source: <http://uplamp.ftmc.lt/>

Day of Photonics 2016 @ FTMC

On 21st of October the FTMC together with Laser & Engineering Technologies cluster (LITEK) invited corporate employees, students, business partners and customers to the Day of Photonics 2016 event dedicated to the detection of the speed of light anniversary.



Presentation @ Day of Photonics © FTMC

Public FTMC lab tours were conducted during the event. Speakers from FTMC – Dr. G. Račiukaitis and Dr. M. Gedvilas and invited speakers: Prof. Y Nishijima (Yokohama National University, Japan), Prof. R. Gadonas (Vilnius University, Lithuania) and E. Dvinelis (Brolis Semiconductors, Lithuania) gave their talks on various laser applications in everyday life. The event was finished with a spectacular laser show.



Lasershow @ Day of Photonics © FTMC

Source: <http://www.appolo-fp7.eu/news.html>

Meet the Consortium

Scanlab GmbH



© SCANLAB

SCANLAB, founded in 1990, is developing and manufacturing galvanometer scanners and scan solutions. SCANLAB's products turn lasers into precise, highly dynamic and flexible tools that provide the basis for performing countless processing tasks.

Our highly qualified and motivated team of 260 employees possesses extensive market and application experience. SCANLAB's headquarters in Germany now manufactures and globally sells more than 20,000 scan solutions annually. As a market leader, the company disposes over the largest installed base in the world. SCANLAB's headquarters as well as the main R&D and manufacturing site is based in Puchheim, Germany (Greater Munich area). The SCANLAB Group employs industry and application experts around the world for the best on-site support.



Headquarters of Scanlab GmbH © Scanlab

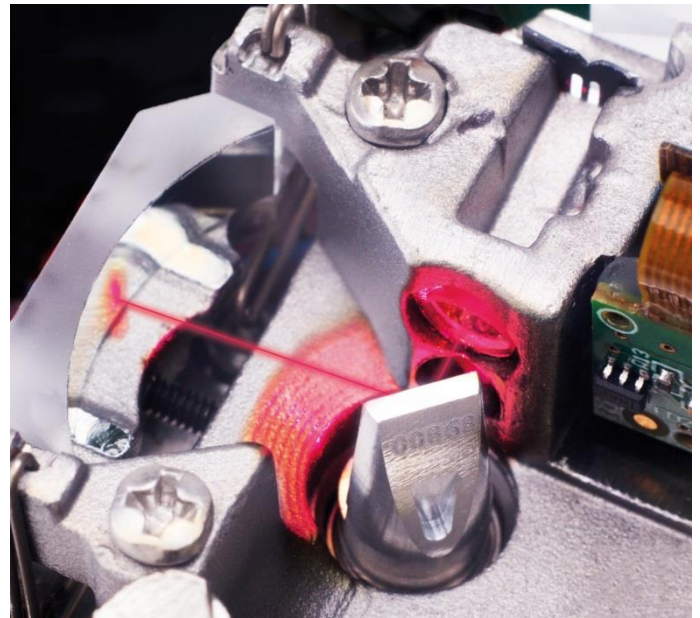
SCANLAB's representation in the US is done by SCANLAB America, Inc. – in Saint Charles, Illinois and Billerica (near Boston), Massachusetts. SCANLAB's associated company Blackbird Robotersysteme, specialising in robot-assisted laser welding, is headquartered in Garching, Germany. The International sales and services are supported by Blackbird Robotics corporations in the USA (Novi, Michi-

gan) and China (Shanghai). SCANLAB's Polygon Scanner Competence is located in Evergem, Belgium, at the associate company Next Scan Technology.

SCANLAB's team of sales and advisory experts promise to speedily and efficiently implement customers' requirements and requests and to support the business partners to address best their market segments. Additionally, they are actively assisted by an experienced R&D team with specialists in electronics, software, mechanics and optics.

SCANLAB maintains its own superbly equipped laser and measurement lab, where individual tests and application experiments can be performed in order to qualify systems for single application requirements.

The SCANLAB engineers are motivated by inquisitiveness and an unceasing drive to find the best technically and economically feasible solution for customer applications. They carefully listen to customers, seek to identify market trends at an early stage, establish new applications and readily welcome innovation. After all, this dynamic market condemns the complacent to be left behind. That is why the company continuously develops new scan solutions for different users.



SCANLAB se digital encoder © Scanlab

The aim is to contribute decisively toward creating new application areas for lasers. Moreover, SCANLAB intends to continue setting new standards and extending industry standards which were already introduced.

Interview

with Georg Hofner, CEO of SCANLAB GmbH



© SCANLAB

What are the biggest challenges in the field of laser-based manufacturing today?

In the last 30 years lasers in manufacturing have developed from a niche technology for specialized high-end applications into standard equipment for various industrial applications with a vast diversity of specific requirements. The continuous progress in the photonics sector enables more and more new commercial applications by making higher laser performance at a lower price available. To translate the advances in laser technology to successful applications, proper machine and beam guiding technology are needed to turn the laser into a powerful and versatile tool for manufacturing. The development of new laser processes is closely intertwined with the development of laser machines. Thus the implementation of new industrial applications needs the joint initiative of laser, beam guiding and laser process development, while each of these tasks needs special expertise to meet today's demands.

To which extent APPOLO can help to face those challenges?

SCANLAB is specialized in the development of scan systems based on galvanometer scanner technology. The APPOLO Hub can help SME system integrators and SME end-users to identify and to refine their requirements for scan systems by providing the expertise of the laser application labs of the APPOLO Hub.

In the framework of the APPOLO project our advanced scanner technology for very dynamic and precise beam positioning will be challenged in micromachining applications to illustrate its potential for the market and the laser industry.

In the APPOLO project, SCANLAB is supplying advanced galvanometer scanner technology for three different experiments (FAST, FastGALVO and LADRUM), which essentially all aim for high-throughput laser surface structuring while having all own characteristic requirements.



SCANLAB excelliSCAN scan-system © Scanlab

The experiments are supported by customising and supplying scan systems for the partners' testing activities – employing newest technology recently developed by SCANLAB like the SCANahead control or *dynAXIS_{se}* digital-encoder galvanometers. Based on the project partners' requirements and the feedback on their experimental results, the scan systems will be optimised for the respective target application.

Article on APPOLO Accomplishments @ LSE

The recent achievements of the APPOLO Project have been mentioned in a short article within issue 33 of the Laser Systems Europe Journal. Among other topics the implementation of new lasers and polygon scanners to improve the validation process of thin film scribing in CIGS solar cells and the developments concerning the handling procedures of perovskite-based solar cells due to experiments have been mentioned positively.

Source:

<http://content.yudu.com/web/tzly/0A41w73/LSEWINTER2016/html/index.html?page=6>

Lightmotif B.V.

Lightmotif

©LIGHTMOTIF

Interview

with, Max Groenendijk, CEO of
LIGHTMOTIF B.V.



©LIGHTMOTIF

What are the biggest challenges in the field of laser-based manufacturing today?

Especially in the area of laser micromachining we see an increasing variety of applications, and each can demand quite different solutions in terms of processes and equipment. We also see an increase in equipment diversity, for example lasers with new parameters and new laser beam deflection systems. It is very difficult for an unexperienced new user of laser technology to find the right solution for its application. With ultrashort pulse laser machining also the processes get more complex, and you will need an experienced and probably specialized partner to help you develop a new process.

In the niche that Lightmotif focuses on, which is texturing and micromilling of tool and mold surfaces, the specific challenges are increasing demands for accuracy. This can only be solved by combining excellent processes with highly accurate and adaptive machining systems.

To which extent can APPOLO help to face those challenges?

For new industrial users of laser technology it is impossible to know which laser equipment and process expertise he needs for his application.

The APPOLO HUB of Application Laboratories offers a solution to this problem by combining expertise and equipment of leading labs into one pool. You can ask your question once, and the HUB can offer a good fitting partner with the right expertise and equipment. This will help to answer feasibility quickly and to develop an initial solution, which can later be picked up by an integrator to transfer it to an industrial process and machine. The APPOLO project furthermore develops novel solutions for micromachining for a diverse range of applications, each in a separate smaller sub-project. These projects involve innovative and specialized SME companies that team up with application laboratories and end-users to bring innovative technology closer to market readiness. Projects like APPOLO thereby help to cross 'the valley of death' for these innovative SME companies.

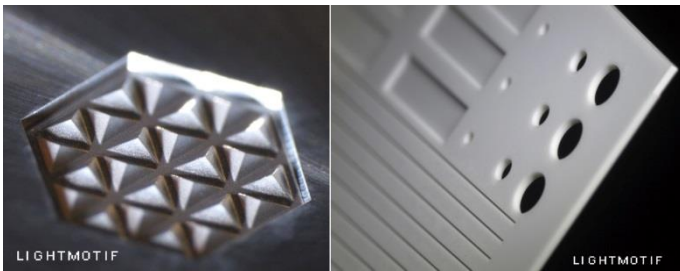
Lightmotif offers solutions for micromachining and surface texturing using ultrashort pulse lasers. These lasers enable highly accurate laser micromachining processes and are capable of machining any material with minimal damage. The unmatched versatility of this new production tool enables manufacturing of improved products or products with new functionality. Lightmotif develops and sells high-end machines, supports customers in process and application development, and offers job-shop services.

Lightmotif was founded in 2008 as a spin-off company of the University of Twente and the Materials Innovation Institute (M2i). By combining their knowledge and experience in ultrashort pulse laser processing, software development, and mechanical engineering, the founders wanted to deliver better laser processes and machines. In 2009 the company moved into its own building at the Business and Science Park in Enschede, where a modern applications laboratory and production facility has been established in a cleanroom environment.

During the first years, Lightmotif concentrated on technology development. This resulted in a flexible micromachining concept that uses advanced control software developed specifically for laser micromachining. With this system large and complex jobs can be executed, also on 3D

curved surfaces. In 2012 Lightmotif started selling systems based on the technology that was developed during the first years. With this step, the company can fully support customers from process development to industrial use, either by offering job-shop services or by selling a production system. Lightmotif's mission is to provide a combination of state-of-the-art ultrashort pulse laser micromachining systems and carefully developed laser processes that enable its customers to make exciting new products; or simply gives them a better way of making their existing products.

The technologies that Lightmotif can offer range from micromilling, drilling, cutting to surface texturing. An example of a micromilled 3D structure is presented below. Here a hexagonal pocket with elevated tetrahedrons is machined into tungsten carbide. This technology results in accurate structures and an excellent surface finish.



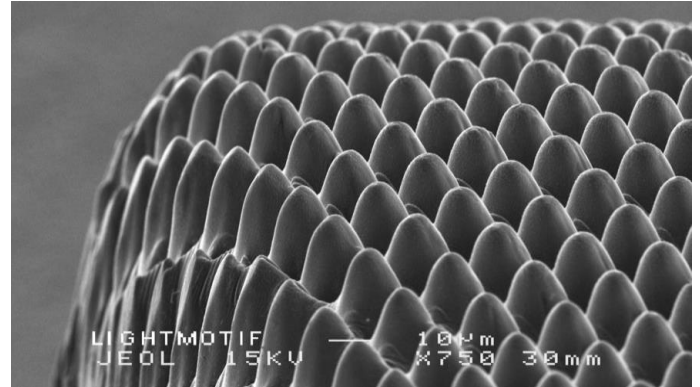
Example of micromilled 3D Structure & Sample of Micromachining © Lightmotif

The different micromachining techniques can be applied to any material. Examples of drilled holes, through cuts and milled pockets in an alumina sample are shown above.

Surface texturing – also referred to as surface structuring – is the process of applying a specific roughness onto a surface in order to change its properties. Ultrashort pulse lasers offer many new possibilities to tailor surface textures and control their properties in a way that cannot be matched by other techniques. Textures with features on multiple scales can be applied, starting in the nanometer range and extending up to the millimeter range. The technology furthermore can be applied on any material and can be used for texturing 3D curved surfaces.

Ultrashort pulse laser texturing enables many new applications of engineered surfaces, where specific surface textures can be used to influence the functional properties, e.g., the wetting, tribological, or optical properties. Such surfaces are also referred to as functional surfaces. The micro-texture presented in the image below can be used to alter skin friction for example. By reducing the contact area

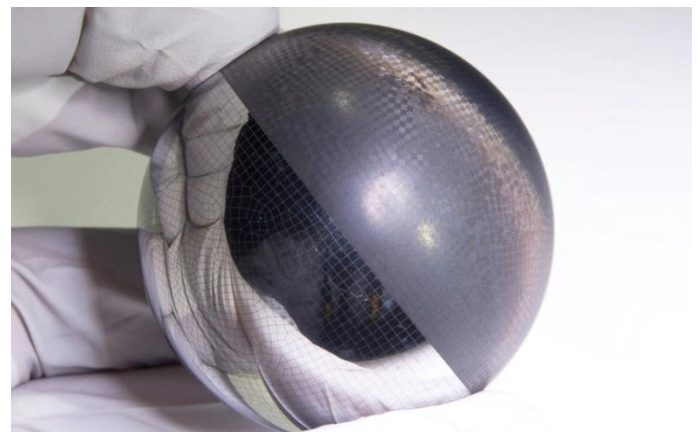
with these textures surfaces can obtain a silky smooth touch.



Texture on large and curved 3D Structure © Lightmotif

Lightmotif has developed a technology to apply textures to large and 3D curved surfaces. For this, a high precision 5-axis manipulator was designed and integrated. This machine can handle large workpieces with a weight of up to 300 kg. To apply the textures to large or curved parts the surface is first divided into tiles, based on a surface description like a CAD file.

These tiles can be textured one after the other using our step-and-scan approach. The textured steel ball shown above illustrates this technique. The upper part is fully covered with a texture that has been distributed into each single tile. On the lower part, only the tile boundaries are marked to demonstrate the tiling approach.



Textured Steel Ball © Lightmotif

In the APPOLO project, Lightmotif works with CRF in the production of automotive interior parts with a soft touch surface. For this goal, injection moulds have to be textured using Lightmotif's 3D texturing technology. An example of an injection moulded plastic part with a soft touch surface is shown in the picture below. Within APPOLO Lightmotif will improve and validate the technology with the goal to offer 3D mould texturing services to industrial customers.

IT4IP SA



it4ip
ION TRACK TECHNOLOGY

©it4ip

The privately-owned company it4ip SA is active in the field of track-etched polymer membranes (i.e. filters).

The it4ip product portfolio consists of polymer membranes with pore sizes in the range of 0.01 to 30 μm and a well-controlled density ranging from $1 \cdot 10^3$ to $6 \cdot 10^9$ pores/ cm^2 . The membranes are mass produced from polycarbonate or polyethylene terephthalate films. On the contrary, polyimide membranes are produced, for the moment, at lab scale.

Track-etched membranes can be used in numerous filtering applications, such as detection of bacteria and the detection of cancer cells in health and medical care. The production of track-etched membranes consists basically of two successive steps: linear tracks are initially created in a thin polymer film by high-energy heavy-ion bombardment (see Figure 1) and subsequently etched using a chemical attack until the correct pore size is attained (see Figure 2).

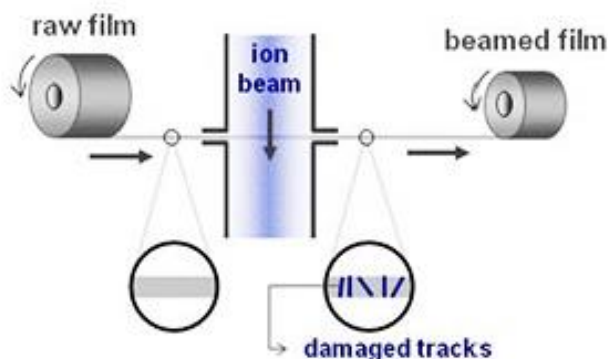


Figure 1: Production track etched membranes: polymer film is bombarded with high-energy heavy-ion radiation © it4ip

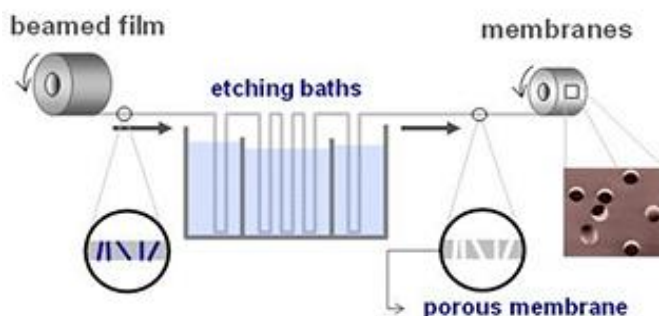
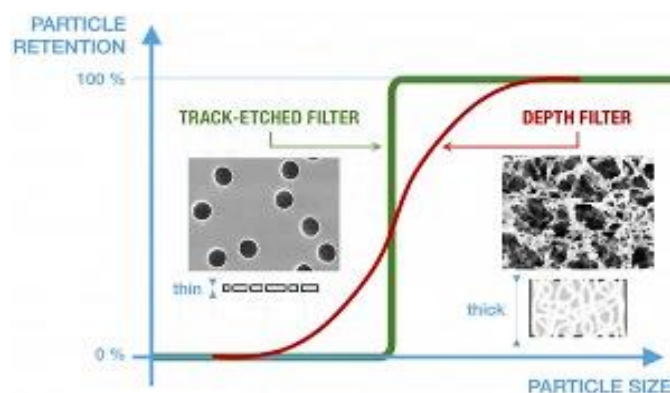


Figure 2: Production track etched membranes: film etching using a chemical attack to create the pores ©it4ip

The process permits for a continuous production of about 250 m^2 of membranes per day. It4ip track-etched membrane filters offer accurately controlled pore size distribution and higher strength and flexibility, which ensure reproducibility and consistency. We offer a wide selection of membrane filters made from high purity polycarbonate (PC) and polyester (PET); polyimide (PI) is also available for specific applications requiring enhanced chemical, physical and thermal resistance properties.

It4ip track-etched membrane filters are manufactured through a process using proprietary technology from high purity raw polymer films, in clean rooms and following the highest quality standards. This unique process ensures that physical properties of each membrane precisely fit client specifications. The physical mechanism at the base of the pores appearance intrinsically yields a narrow pore size distribution, providing **sharp cut-off filters**. They, therefore, enable efficient size exclusion of particles (nano- & microparticles, microorganisms), in filtration or detection applications.



Membrane Performances ©it4ip

It4ip membranes feature a sharply defined cylindrical shape. This shape is conserved even at pore dimensions ranging from 10 nanometers to over 30 micrometers. This

outstanding shape and dimensional control make them suited for the most demanding filtration operations, but also as a template for the synthesis of 1D nano- or micro-objects.

Because of the **very low filter thickness** and of cylindrical nature of the pores produced by the track-etching process, most of the filtration process occurs at the pores mouth. Combined with their **smooth and flat surface**, these track-etched filters are therefore ideal for detection of retained particles. Besides the pore size, it4ip membranes are produced with a **well-defined pore density**. Densities start below 1000 pores per sq. centimeter ($1 \cdot 10^3 \text{ cm}^{-2}$) to reach over 6 billions pores per sq. centimeter ($6 \cdot 10^9 \text{ cm}^{-2}$). This flexibility enables an accurate control of the membrane characteristics as a diffusion regulator. State-of-the-art track-etching technology can be applied to polycarbonate (PC), polyester (PET) and – it4ip exclusivity – polyimide (PI).

Intrinsic properties of raw films provide following benefits:

- **low extractable** to ensure tests will be clean and promote consistent results
- **low protein binding** to minimise loss of protein analyses
- **negligible adsorption and absorption** of filtrates to maximise critical solution recovery
- **biocompatibility**: our membranes are non-cytotoxic and non-bactericidal; they meet biosafety requirements of the USP Class VI tests
- our membranes can be **autoclaved** (30 mins @ 120°C), or **sterilised** using EtO or gamma radiation
- excellent chemical resistance and thermal stability can be significantly strengthened (350°C; 660°F) by the use of polyimide

It is possible to modify the surface state of the membranes to obtain additional properties. Water contact angle can be tuned at wish from hydrophilic to hydrophobic. Also, surface treatment to increase cell growth and binding during cell culture are available. Beyond that, the membranes can be metal coated for specific applications (Ag, Au, Cu, Al and Ti available).

It4ip is involved in the PONT project, which is part of the APPOLO project portfolio. The project aims at evaluating the performances of a resonant near-infrared ablation in the spectral range of 1500-2000 nm with that of the above-

mentioned track-etching process. This consists of creating pores of precisely defined diameter, ranging from 1 to 10 μm , in polyethylene terephthalate and polycarbonate, or even any other film of a thickness in the range from 8 to 80 μm . Furthermore, surface (pattern) texturing, is very much of interest as a precursor to the classic track-etching process.

The laser technology is considered to perform holes in polymer films and thin layer shaped devices using two new sub-nanosecond laser sources. Compared to track etching, the laser technology provides favourable improvements, especially for low pore density of ≤ 1000 pores per cm^2 .

Interview

with Guido Heunen, Process Manager @ it4ip

What are the biggest challenges in the field of laser-based manufacturing today?

As it4ip operates in the chemical sector, we are not familiar with (general) laser-based manufacturing and its current (biggest) challenges.

However, it4ip activities in track-etched polymer membranes face a challenge as customers inquire about filters with low pore densities (i.e. <1000 pores/ cm^2) and pore sizes ranging from 10 nanometers to 30 micrometers. Considering that the current manufacturing technology is limited to pore densities within the range of $1 \cdot 10^3$ and $6 \cdot 10^9$ pores/ cm^2 , alternative production techniques are being investigated; like laser-based manufacturing. Here, the main challenge lies in the lowest pore size attainable with current or new and innovative laser techniques.

To which extent can APPOLO help to face those challenges?

The PONT project, with the development of a new and innovative laser, challenges pore sizes to be low as 1 micron and pore densities below 1000 pores/ cm^2 . It4ip will assess the resulting membranes on their quality and precision. Furthermore, this hi-tech industrial process will be evaluated for its productivity and economic impact.

Upcoming Events 2016

05.06. – 08. 06.	Toyama, Japan	18th International Symposium on Laser Precision Microfabrication
26.06. – 29. 06.	Munich, Germany	Lasers in Manufacturing 2017
26.06. – 29. 06.	Munich, Germany	Laser World of Photonics
03.07. – 07.07.	Vilnius, Lithuania	APPOLO Summer School on Ultra-short Pulse Lasers Applications in Material Processing
03.09. – 08. 09.	Marseille, France	International Conference on Laser Ablation

LPM 2017

The **18th International Symposium on Laser Precision Microfabrication** (LPM 2017) will take place from June 5th to 8th, 2017 in Toyama, Japan.

LPM is the world's number one meeting of the laser user community where the most advanced developments and recent trends in laser application for fine and precise fabrication of diverse materials are discussed between industry, research and academia.

The symposium provides unique opportunities for researchers all over the world to discuss matters from a variety of different subject specific theme areas. Two invited talks will be presented by APPOLO partners.

Moreover, based on the knowledge generated within APPOLO project, a special session on "Optimisation of laser ablation processes using ultrashort pulse lasers" is organized by APPOLO HUB team lead by Dr. G. Račiukaitis and Prof. B. Neunschwander with more than twenty presentations on various aspects of utilization of laser energy for precise and efficient material processing.

<http://www.jlps.gr.jp/lpm/lpm2017/>

LiM 2017

The **Lasers in Manufacturing** conference of the WLT will take place from June 26nd to 29th, 2017 in the International Congress Center in Munich, Germany.

The **LiM-Lasers in Manufacturing** is the perfect platform for efficient knowledge transfer in the field of lasers and their applications. The LiM focuses on the latest developments as well as future trends in the field of laser materials processing. The conference topics addresses everyone who is interested in the potential of lasers in manufacturing is the theory and application. It is the aim to bring together international experts from research and industry in order to match scientific advances and economic need for mutual benefit.

The LiM is a part of the World of Photonics Congress 2017. This allows the coordination of joint sessions in order to highlight topics at the interface of the thematic areas covered by the participating conferences.

<http://www.wlt.de/lim/>

COLA 2017

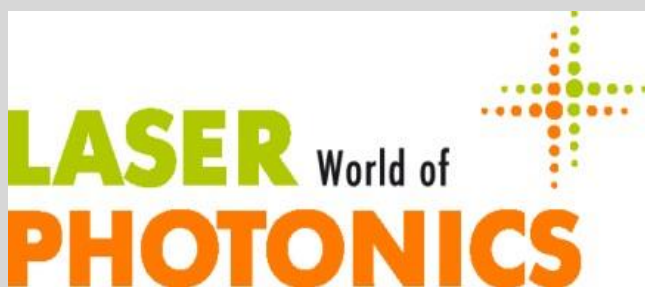
The **Conference on Laser Ablation (COLA) 2017**, will take place in Marseille (France) from 3 to 8 September 2017.

Since 1991, COLA conference brings together scientists from around the world to discuss the latest scientific and technological advances related to new fundamental and applied aspects of laser ablation.

Laser ablation relies on a wide range of physical and chemical mechanisms taking place at different temporal and spatial scales, starting from attosecond and atomic size. The Scientific community investigates this field for thirty years and numerous questions are still open. Moreover, new exciting challenges continuously appear with the fast technological advances of the laser sources and the characterization techniques.

Laser ablation is also the starting point of a large amount of industrial processes in many application fields like manufacturing, microelectronics, automotive, diagnostics, medical and others. After Cairns (Australia) in 2015, the COLA 2017 will take place in France

<https://cola2017.sciencesconf.org/>



The Laser World of Photonics exhibition will take place from June 26th to 29th, 2017 in Munich, Germany.

As one of the most important platforms for the international photonics industry, the exhibition attracts more than 30.000 visitors and over 1200 exhibitors.

<http://www.world-of-photonics.com/>

APPOLO participation @ Photonics West 2017

APPOLO partners have participated in the world's largest multidisciplinary event focusing on photonics technologies - **Photonics West 2017**, which was held on January 28- February 2 in San Francisco, USA.

During the course of the event following topics have been presented to the audience:

"Influence of the pulse duration and the experimental approach onto the specific removal rate for ultra-short pulses" Beat Jaeggi (BUAS), Beat Neuenschwander, Stefan Remund, Thorsten Kramer

"Influence of the initial surface texture on the resulting surface roughness and waviness for micro-machining with ultra-short laser pulses" Stefan M. Remund (BUAS), Beat Jaeggi, Thorsten Kramer, Beat Neuenschwander

"Dynamic fiber delivery of 3 W 160 fs pulses with photonic crystal hollow core fiber patchcord" Bojan Resan (LUMENTUM), Raffael Auchli, Ronald Holtz

"Assessment of geometry in 2D immune systems using high accuracy laser-based bioprinting techniques" Sara Lauzurica, Andrés Márquez, Carlos Molpeceres (UPM), Laura Notario, Miguel Gómez-Fontela, Pilar Lauzurica

Source: <http://www.appolo-fp7.eu/news.html>

Source: <http://uplamp.ftmc.lt/>

APPOLO provides Co-Chairs of Photonics West LASE Conference

For the annual SPIE Photonics West Lase Conference, Gediminas Račiukaitis (Center for Physical Sciences and Technology (FTMC), Lithuania) and Beat Neuenschwander (Bern University of Applied Sciences (BUAS) have been conference co-chairs. Guido Henning from Daetwyler Graphics AG is serving as the LASE conference chair for many years.

Source: <http://www.amshow-europe.com/iris-srl>

Consortium

appolo



Coordinator

State research institute Center for Physical Sciences and Technology (FTMC)

Department of Laser Technologies
Savanoriu Ave. 231, LT-02300 Vilnius, Lithuania

Tel.: +370 5 264 9211, 266 1640/1643,
Fax: +370 5 260 2317

Contact Person

Dr. Gediminas Račiukaitis

Head of Department of Laser Technologies, FTMC

Tel.: +370 5 264 4868

E-Mail: graciukaitis@ar.fi.lt

