APPOLO - Hub of Application Laboratories for Equipment Assessment in Laser Based Manufacturing

Collaborative Project of 7th Framework Programme

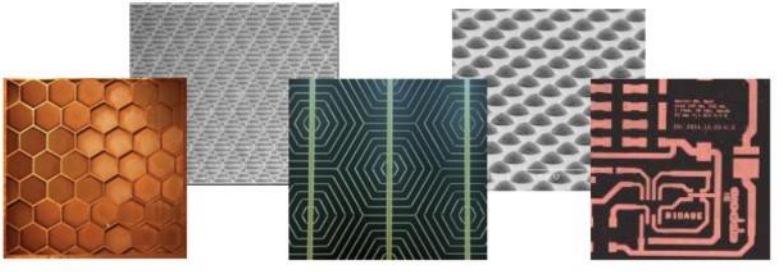
FoF-ICT-2013.7.2 Equipment assessment for sensor and laser based applications

EC Grant Agreement N° 609355

Start: 01 September, 2013; End: 31 August, 2017

Project duration: 48 months

www.appolo-fp7.eu



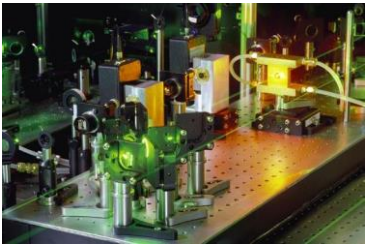
Lasers have been approved as a tool for diverse material processing. New application ideas, come from universities and research institutions, are implemented by spin-offs, but effective and low-cost production requires equipment assessment for the end-user.

Goal of APPOLO

to exploit distributed knowledge, existing at

- academic application labs,
- equipment manufacturers,
- system integrators,
- end-users

and to enable the development of industrial laser processing for innovative products, technologies and machineries.



APPOLO Objectives

Establish and coordinate connections between

- the **end-users**, which have demand on laser technologies for (micro)fabrication;
- knowledge accumulated in the **application laboratories** of research institutes and universities;
- the laser **equipment manufacturers** (preferable SMEs: for integration, lasers, beam control and guiding, software, etc.)

Facilitate

faster validation of the process feasibility, adaptation or customization of the technology & equipment for manufacturing conditions, including:

- reliability of the components;
- their interaction;
- assessment of the dedicated production processes;
- process speed, quality and repeatability;
- socio-economic issues.

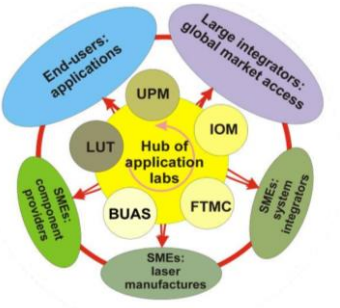
We are part of I4MS

APPOLO HUB

www.appolohub.eu

APPOLO HUB is a network of laser application laboratories providing laser micromachining assessment services for industry partners.

APPOLO HUB offers service to assess and verify novel laser manufacturing technologies for industrial use.
HUB is performing the testing activities at one in **6 laser application laboratories,** located in Switzerland, Spain, Germany, Netherlands, Finland and Lithuania.

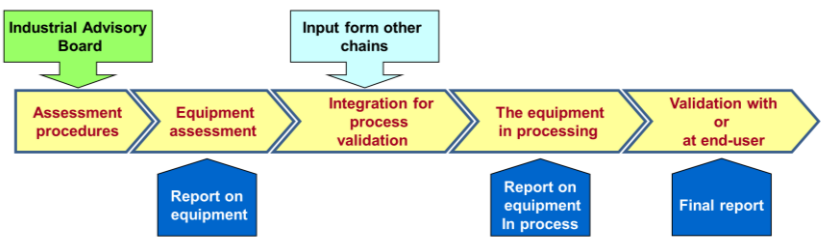


► Assessment of laser equipment
We assess new lasers, scanners, beam guiding equipment and laser workstations to verify how they meet customer expectations.

► Laser processing verification
We offer service to define the optimal laser equipment for your samples and products with **ns, ps and fs** laser beams.

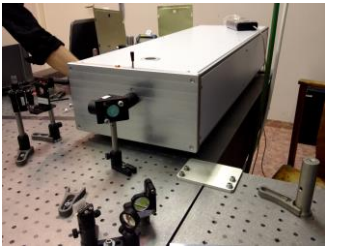
► Laser micromachining Ownership Costs & Benefits
Information about costs and alternatives for ultras short pulse laser processing: Analysis and limits of laser processing parameters; Process flow analysis; Cost-of-ownership estimations including maintenance requirements & lifetime.

15 Complex Assessment Value Chains

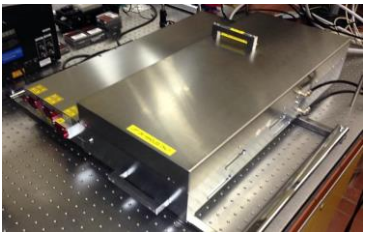


Equipment on validation

Atlantic ps-laser (Ekspla)



1342 nm ps-laser (Ekspla)

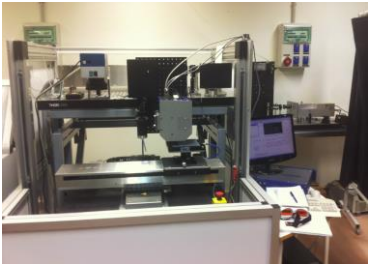


Genki ps-laser (onefive)

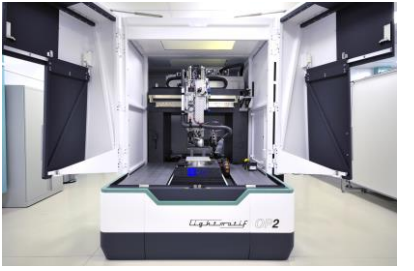
100W, 1 ps laser (Lumentum)

Polygon scanner LSE300
(Next Scan Technologies)

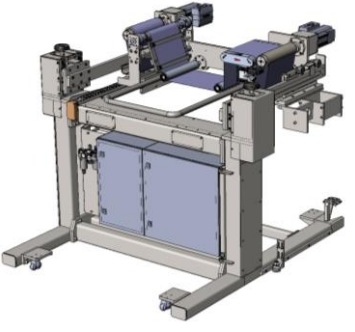
Polygon scanner LSE170HNA
(Next Scan Technologies)

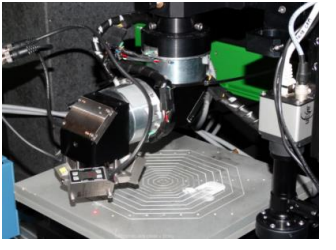


Test-bench for UPM (Mondragon)



New design laser texturing machine (Lightmotif)

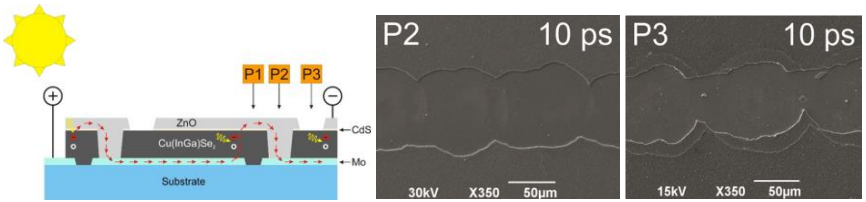




Add-ins to DuoMASTER laser system (ELAS): roll-to-roll setup and robotic hand for 3D processing.

Novel lasers & thin-film scribing concepts for solar cell

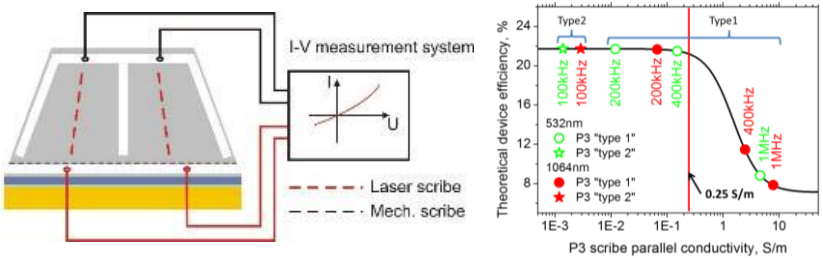
Laser scribing is a way to maintain the PV module efficiency by dividing a large scale device to smaller cells interconnected in series. Three scribing processes called P1, P2 and P3 are needed for monolithic interconnection.



Schematic view of the CIGS module series interconnect formed with three step laser scribing. SEM images of the P2 and P3 lift-off scribes in CZTSe samples.

On-line control of the scribing process

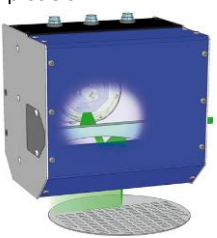
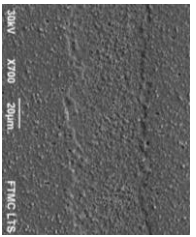
Laser processing of CIGS solar cells can induce undesirable shunting paths resulting lower module efficiencies. A technique for electrical characterization of the laser scribe was developed. It can be implemented at the early stages of the laser process development, and the scribe specific conductivity values can be extracted by fitting the results with a simple linear function.



Experimental setup of the Linear Laser Scribing Technique (LLST) for in-process parallel resistance measurement in a fully functional mini-cell. PV efficiency dependence on the shunt resistance due to the P3 laser.

Intelligent laser beam control & integration into machines

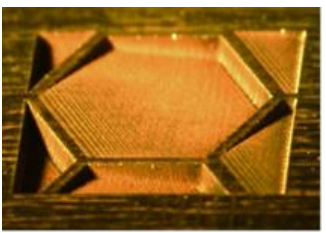
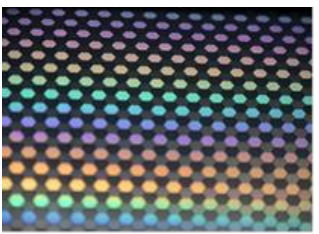
Picosecond lasers in many cases have shown excellent results of material processing for diverse applications. Polygon scanner from Next Scan Technologies provides means to control laser beam in space at the speed of 100 m/s. The technique has been tested for various applications unifying processing qualities: speed, power and precision.

Picosecond laser Atlantic (Ekspla) and polygon scanner LSE 170 (Next Scan Technologies) provide opportunity to reach the removal of the full CIGS structure to expose the molybdenum back-contact at the scribing speed of 50 m/s.

Laser texturing for printing/ decorative applications

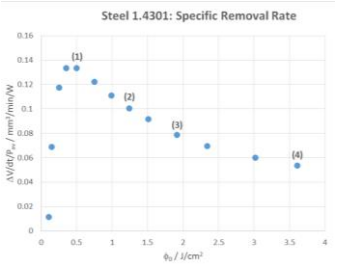
The production of advanced packaging designs is an extremely fast growing market. The fast and flexible engraving of rotating cylinder is a key element in modern industrial printing and embossing.

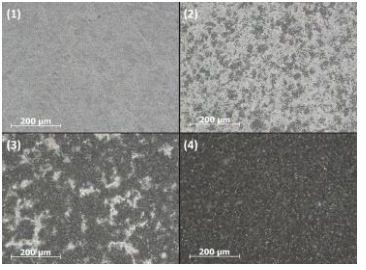



Laser processing with ultra-short laser pulses gives the possibility for texturing of surfaces with sub-micrometre size structures. Due to the small, size these structures are optical active and give the product designers an unexplored option in terms of appearance and functionality.

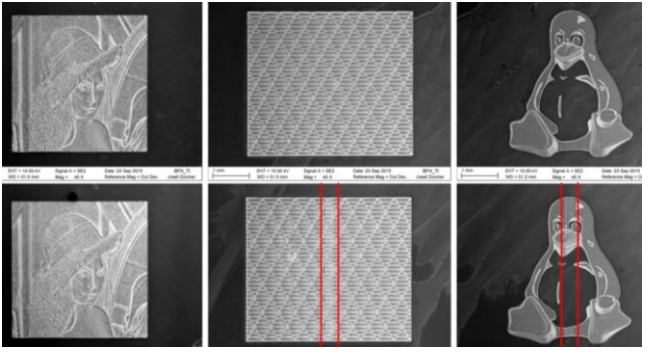
High speed & precision laser texturing

High presition and efficiency is related with efficient use of laser energy. Detailed investigations on influence laser fluence, scanning speed and overlap on volumetric removal reate and surface morphology approved the proposed model which provides guideline for laser power upscale useful in laser microfabrication.





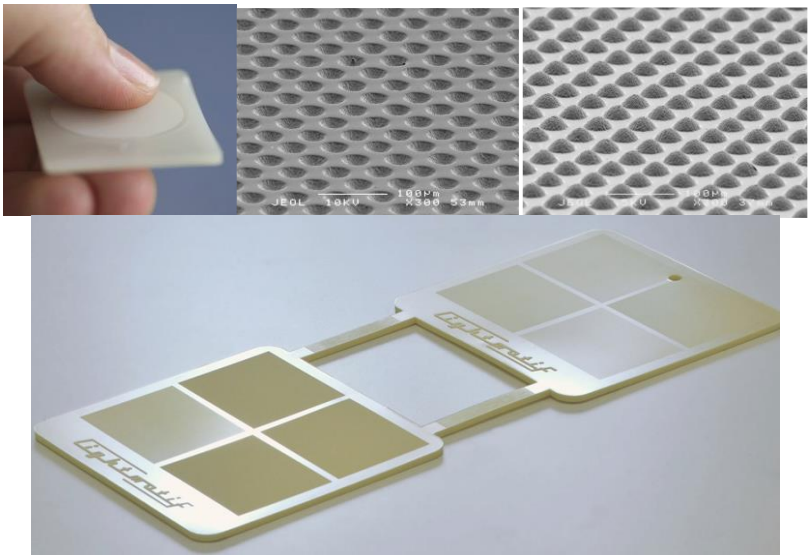
Stitching strategies for real large-size 3D texture structures were developed.



SEM images for 3 different 3D-structures; upper row: non-stitched images; lower row: stitched images.

Dedicated nanostructures on moulds for surface functionalization

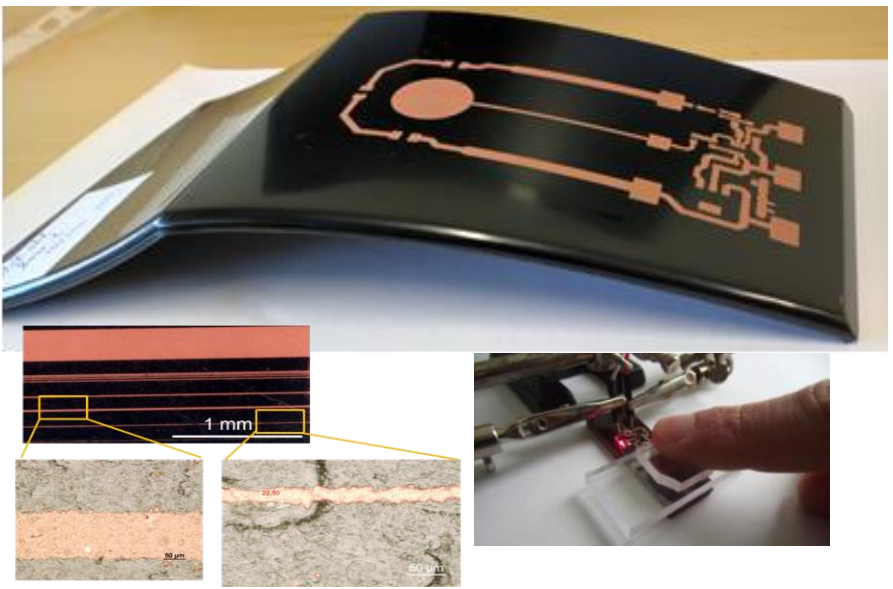
Replication of functional surfaces on polymer can be achieved by texturing the mould. Lightmotif and CRF cooperate with the goal to obtain a method that enables the production of polymer parts for car interiors with added functionality due to a micro- and nano-textured surface, achieved by a textured mould. The surfaces should show a “soft-touch” effect that results from a largely reduced contact area of skin and polymer part.



SEM images of dimples produced by laser trepanning and their replicas made by injection moulding. Injection moulded demonstrator with different soft-touch / anti-glare micro-pillar textures.

New laser activation and chemical deposition concepts

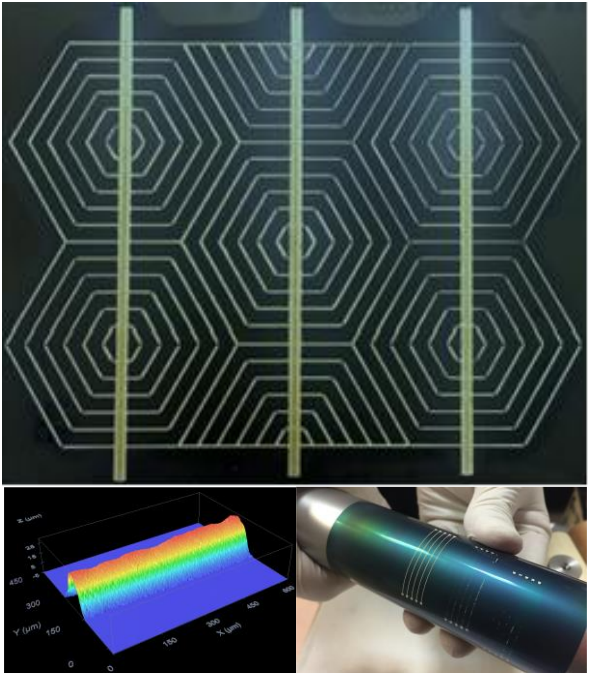
Both, laser-induced surface activation and selective electroless metal deposition were advanced in creating Moulded Interconnect Devices (MID). The main aim is to perform surface processing validation on standard automotive plastics instead of using highly specialized material with expensive additives.



Selectively plated copper on Polypropilene surface and functional capacitive sensor demonstrator.

LIFT process for top contacts in photovoltaics

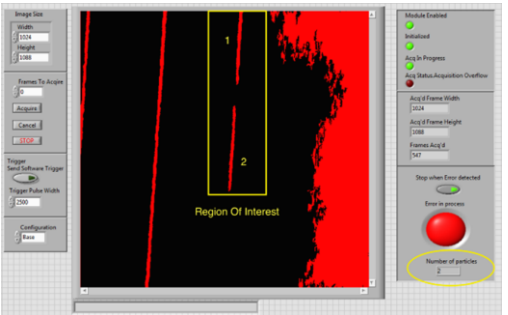
Laser-Induced Forward Transfer (LIFT) process was successfully validated for free-form front contact grid printing with picosecond lasers on silicon solar cells.



This allows the printing of different grids just changing the program for the scanner giving great process flexibility.

Development of sensing and monitoring techniques for processing and validation

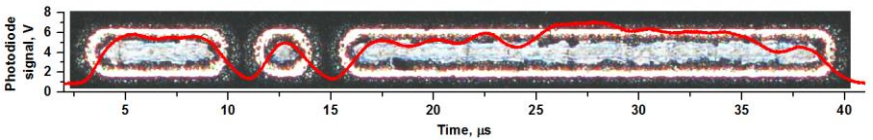
On-line detection of defects during laser scribing with galvoscanner.



With a high speed camera (max 500 fps), recognition of the defects was achieved at the maximum speed of 1100 mm/s. This was demonstrated for CIGS P3 type 1, Cr/Glass P1 and Mo/PI P1 processes.

On-line monitoring of the laser process running at 50 m/s speed trough polygon scanner.

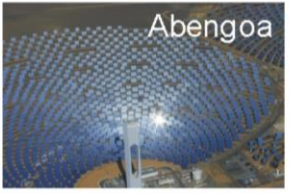
The special optical system was developed to measure the reflection signal from the surface during the laser fabrication process. Such system helps to instantly detect defects in the fabricated profile and perform online monitoring of the laser process.



Microscope image of the P3 scribe made in the CIGS solar cell by direct laser ablation and the photodiode signal measured on-line during the ablation process.

Application areas of APPOLO technologies

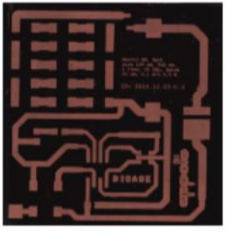
Photovoltaics



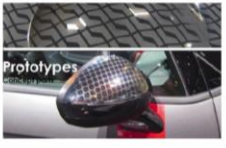
Jewellery

Printing and embossing

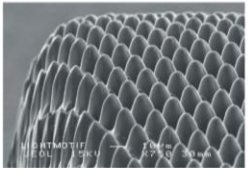
Electronics



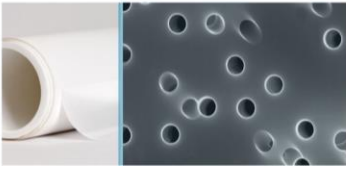
Automotive



Machinery



Biomedicine



Consortium

SUPPLIERS:

EKSPLA · LUMENTUM · onefive · LaserSpec · next scan technology · lightmotif · AMSYS, LTD. · SCANLAB · lasing, s.a. · OPI Photonics

APPLICATION LABORATORIES:

FIZINIŲ IR TECHNOLOGIJOS MOKSLŲ CENTRAS · IOM · POLITÉCNICA · Bern University of Applied Sciences · LUT Lappeenranta University of Technology

SYSTEM INTEGRATORS:

MONDRAGON ASSEMBLY · elas · sisma GROUP · Osai automation systems · IRIS

END-USERS:

CENTRO RICERCHE FIAT · Daetwyler Graphics · BIOAGE · BOSCH · SWG · ABENGOA SOLAR · Flisom Flexible Solar Modules · SKF · Nanotypos · it4ip · GE · MAIER · LAC Italy

MATERIALS:

EMPA Materials Science & Technology

IPR MANAGEMENT & EXPLOITATION:

engage Key Technology Ventures

COORDINATOR:

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