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NewDeli

Collaborative project
No. 609355 APPOLO
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Dear Subscriber,
Welcome!

*This is the second issue of **NewDELI** project newsletter, a project funded by the European Commission within **Factory of the Future program, FP7.***
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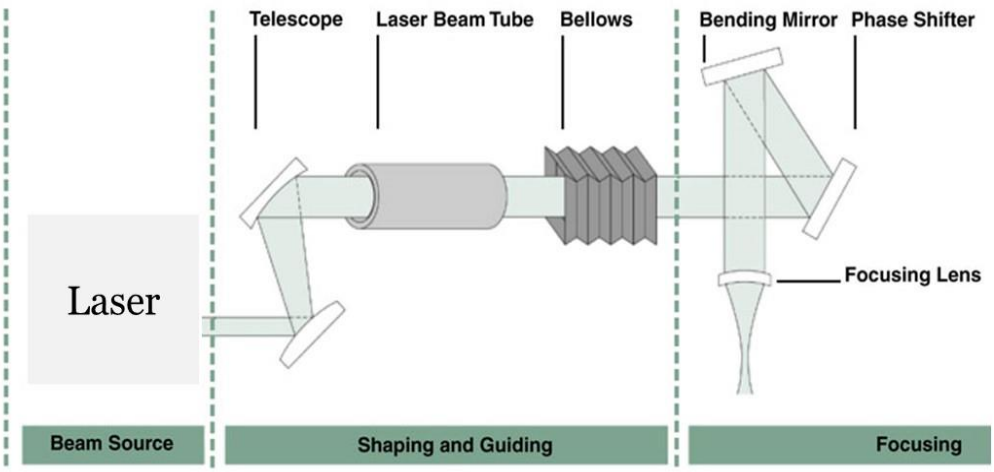
Focus on laser ablation

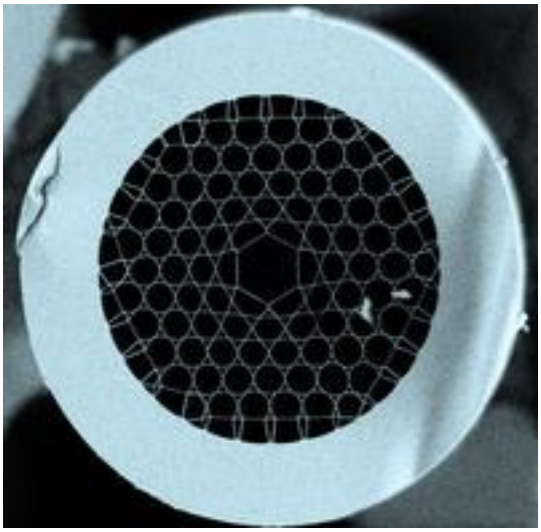
Laser ablation is the process of removing material from a solid (or occasionally liquid) surface by irradiating it with a laser beam. At low laser flux, the material is heated by the absorbed laser energy and evaporates or sublimates. At high laser flux, the material is typically converted to a plasma. Usually, laser ablation refers to removing material with a pulsed laser, but it is possible to ablate material with a continuous wave laser beam if the laser intensity is high enough.
Laser pulses can vary over a very wide range of duration (milliseconds to femtoseconds) and fluxes, and can be precisely controlled. This makes laser ablation very valuable for both research and industrial applications.
Usually very short laser pulses are delivered via air exploiting a very complicated system, as reported in the Figure below. System like this usually suffers of serious disadvantages in terms of reliability and maintenance.



A new class of guiding system

A new class of photonics crystal fibre has been recently introduced in the market. Their peculiarity is to have a hollow core, so the radiation propagates through "nothing". On the right, a picture of a hollow core photonic crystal fibre is reported.

This new type of fibre, will allow to realize a new generation of high power cable with the capability to deliver high power short laser pulses. This robust, fibre-based beam guidance system for ultrafast lasers guarantee maximum transmission and preserve the laser beam parameters. For protection from stress in an industrial environment, the fiber is – as with all conventional guidance systems for high-powered lasers – integrated in a stable laser light cable.



NewDeli's focus

The focus of the project is to exploit this class of hollow core photonic crystal fiber to transport ultrashort laser pulses, thus exploring the opportunities of the market of laser ablation. This technique can be employed in various fields, such as laser polishing, texturing, engraving, marking, laser drilling, glass industry, production of nano-particles of metals, cleaning of surfaces and so on.
However, the focus of NewDeli is directed to **ablation of metals** and, more in detail, the particular process addressed will be **laser polishing**, **laser drilling**, **laser milling** and **laser texturing**.
Functional characterization of surfaces is one of the most challenging field that requires the most precise and smallest surface features. The second reason resides in the fact that the consortium involved in the **NewDeli's project wants to explore and develop the possibilities offered by Additive and Subtractive Manufacturing**, that has brought terrific innovation in the field of complex shape part manufacturing with no additional cost and a more efficient material usage.

System specifications

The design of the cable has been carried out in such a way that it will be able to withstand without particular stresses all the characteristics of fluences, pulse energy and peak power necessary to obtain the manufacturing features that have been identified as representative for the Additive and Subtracting Manufacturing.

The chosen hollow core fibre can handle laser pulses which pulse width can be as short as 500 fs with a maximum pulse energy of 0,5 mJ.

The fibre is single mode and the mode field diameter is 40 microns with an M^2 factor lower than 1,35. This set of parameter allow the cable based on such a fibre to deliver laser pulses that match the requirements described in the New Deli deliverables D1.1 and D1.2.

Exploiting his know how on cable for high power CW laser, OPI is realizing a prototype of cable for hosting the hollow core fibre. In the Figure below, a typical cable with QBH connector is reported.

The cable will have a connector compliant with the Trumpf LLK-B type, will be water cooled and will have a high power AR-coated window to protect the hollow core fibre end.

Industrial process requirements		
Surface polishing	Ti	Roughness: 0,1 – 1,6 µm
Surface polishing	Al	Roughness: up to 6,3 µm
Micro drilling	Al, Ti, Steel	⌀ 10-100 µm up to 1 mm
Milling	Al, Ti, Steel	Feature: 0,005 mm

Delivery system specifications	
Max cable length [m]	6
Wavelength range [nm]	930 - 1100
Pulse duration [ps]	< 1
Pulse energy [mJ]	< 0,5
Max avg optical power [W]	< 50
Input beam M^2 factor	< 1,2
Output beam M^2 factor	< 1,35

Cable features	
Inner hose	Stainless steel
Outer hose	Flexible reinforced plastic
Safety (monitor)	Continuity, breakage and temp

NewDELI's exploitable results

The output of the project will be the realization of a proper delivery system, coupled with an appropriate laser source that is able to process a sample with a given surface quality within a certain processing time. Up to now, three Deliverables have been released, in the framework of WP1:

- D 1.1: industrial requirements;
- D 1.2: cable specifications and constraints;
- D 1.3: validation test plan.

Based on the output of D1.2, an alpha sample will be realized and characterized (WP4) to meet the functional specifications. Then, a final release of the delivery system will be realized to meet all quality and reliability specifications (WP5). At BUAS' lab facilities, in WP6 the industrial validation experiment outlined in D1.3 will be performed. Eventually, in WP7 the delivery system's quality and reliability will be assessed and its robustness will be proved.

Examples of laser that will be used during the validation phase of the cable are listed below

	Onefive Origami – 10 XP	Onefive Katana HP10
Center wavelength	1030 nm	1064 nm
Pulse duration	< 500 fs	30-50 ps
Avg output power	4 W	12 W
Pulse energy	40 uJ	15 uJ
Peak power	100 MW	1 MW
Repetition rate	1 MHz	1 MHz

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