

# High power Adaptable Laser beams for materials processing



## HALO project newsletter #2

October 2013

### Welcome to the second HALO project newsletter!

As HALO completes its first year, this newsletter presents some of the recent results from the project. The overall objectives of HALO are to investigate the simulation of cutting processes, develop new components, experiment with novel laser configurations and advance exciting new processing techniques. More information can be found on the project website ([www.halo-project.eu](http://www.halo-project.eu)), including an overview presentation.

The project has had a very positive start and already several important results have been released into the public domain, including two papers at the NOLAMP 2013 conference (see pg 4). If you have any questions on the project then please feel free to get in touch using the contact information below or from the website.

#### In this newsletter:

- *First results from TRUMPF on adaptable beams for cutting brittle materials*
- *Laser Expertise describes its work on defining the state-of-the-art in laser cutting, including a new book on the topic based on HALO work*
- *Luleå University hosts NOLAMP 2013 (NORdic LAsEr Materials Processing) and represents HALO.*



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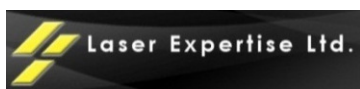
Image courtesy of Fraunhofer ILT

### End user input wanted!

HALO is an industrially-driven project, funded under the “Factories of the Future” initiative, and aims to establish potential exploitation routes for the technology throughout the project. If you are interested in adaptable laser beam technology for a particular application, please contact Tim Durrant or Bruce Napier on the emails given above. The website will be updated with new material throughout the project, so check back, or sign up for the RSS feed for news updates!



TRUMPF



SYNOVA



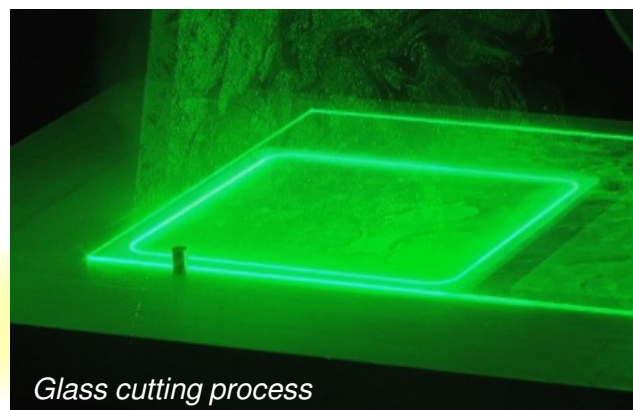
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## Cutting of brittle materials:

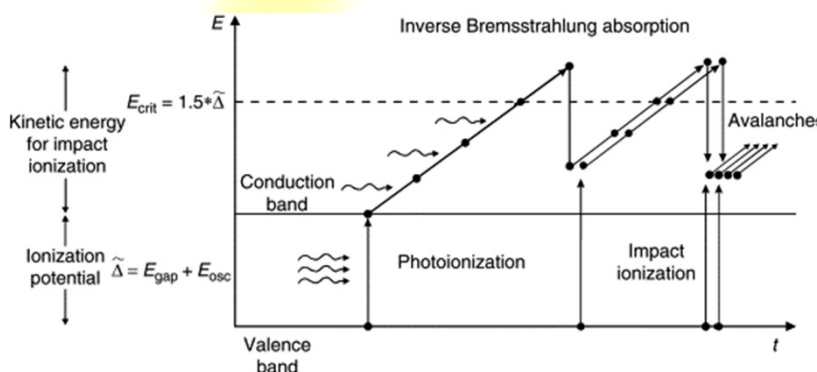
### *The potential of beam-shaping in this key application*

Brittle materials such as glass, ceramics and sapphire have recently found increasing acceptance in industrial sectors. However the cutting of brittle materials is a complex process and there are high demands on the quality of the processed materials. For example, industrial glass sheets need to have extremely low levels of cracks and damage and a high bending stability; ceramics must exhibit very low surface roughness and high dimensional precision; sapphire should not show chipping or micro-cracks.



*Glass cutting process*

Currently non-automated processes dominate industrial manufacture. Non-optimised techniques including mechanical or chemical processes lead to high waste and inadequate material quality which requires post-processing steps and consequently have high processing costs. However, cutting with picosecond lasers could be the solution for processing brittle materials efficiently without time consuming post-processing steps.

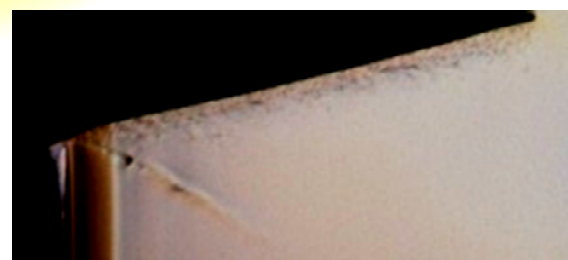


*Schematic of multi-photon ionisation. [From A. Vogel, et al.; Appl. Phys. B 81 1015-1047 (2005).]*

gain kinetic energy by light absorption and can free further electrons, leading to cascade ionisation. In the subsequent decay the electrons transfer energy to the lattice resulting in material ablation.

Within the HALO project TRUMPF has carried out reference cuts on glass, ceramics and sapphire with picosecond lasers to investigate the influence of various parameters on the ablation process. To assess the quality of the sample, a four-point bending test was performed. It was shown that with process optimisation the glass cutting process could be improved to bending strengths >200 MPa. However damage occurred during the process of cutting transparent materials at certain sets of parameters (*right*).

In the next period of HALO, methods to reduce damage and increase the efficiency of the process will be investigated. The extent to which spatial and temporal beam forming can improve the process will be explored, including evaluation of ablation rate and cutting speed as well as quality.

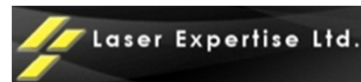


*Cross-section of laser processed glass sample. Damage occurs at certain parameter settings.*



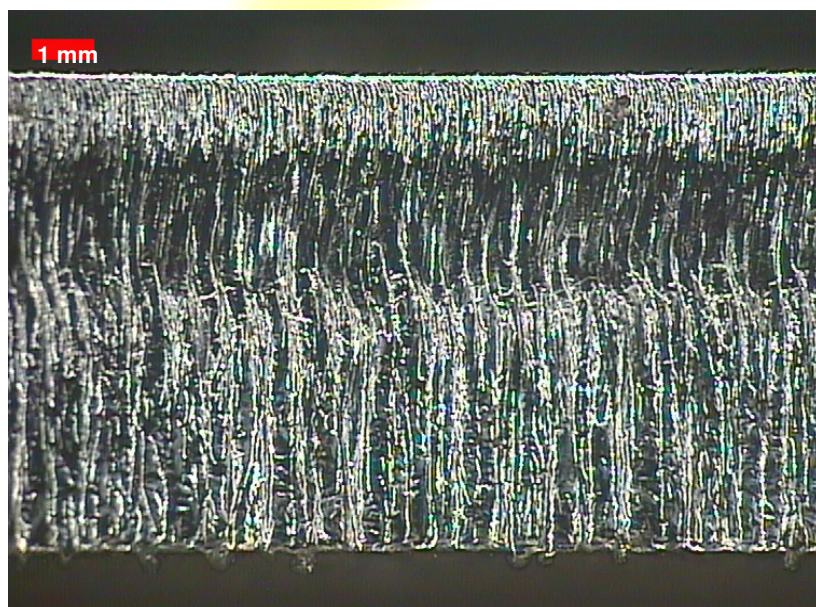


## HALO to define the state-of-the-art in laser cutting



Although laser cutting has been a thriving branch of industry for over thirty years there is no definitive state-of-the-art document from which to compare advances in the subject. Part of the HALO project is to produce a laser cutting state-of-the-art document; and this has led to interest from a commercial publisher (Wiley) and agreement on the production of a book on the subject.

The HALO state-of-the-art work looks at the two features of laser cutting which are of most interest to users and suppliers of the technology: cutting speeds and cut quality. The samples involved are being produced on state-of-the-art industrial machines, rather than under laboratory conditions, in order to give the results the maximum industrial relevance. From the point of view of quality HALO is investigating surface roughness, cut edge inclination, heat affected zones, dross and chemical contamination (e.g. oxidation).



The surface roughness measurements are being made by optical methods in order to give a full view of the cut edge.

In this case, the cut edge itself was produced using a fibre laser from 8 mm thick stainless steel. The figures show:

*Left: Electron micrograph of cut edge.*

*Below left: Colour maps of the top, middle and bottom of cut edge.*

*Below right:  $R_a$  roughness measurements extracted from the colour maps.*

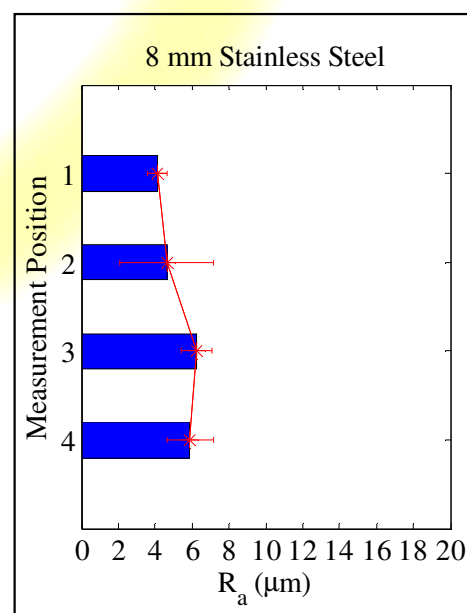
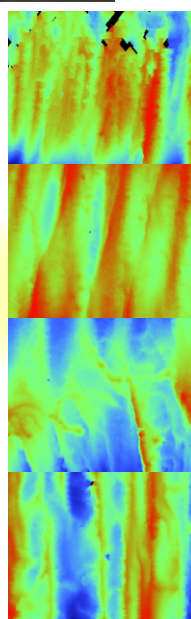
The wide range of results being gathered as part of HALO will be used to identify the quantitative improvements made by other project areas. Moreover they will also be useful throughout the laser cutting community in defining and benchmarking the quality and speeds possible when using laser cutting.

For more information please contact:

**Prof. John Powell**

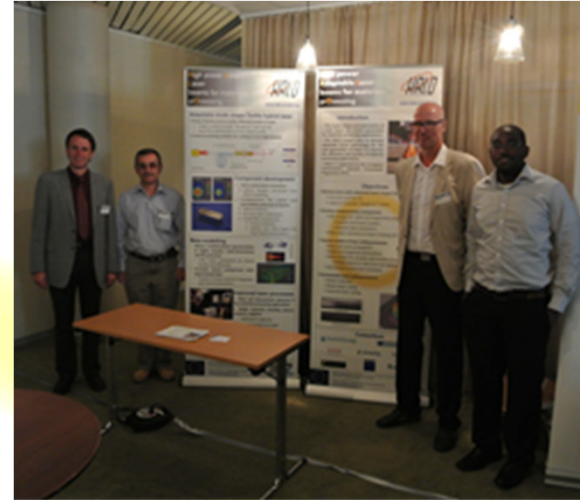
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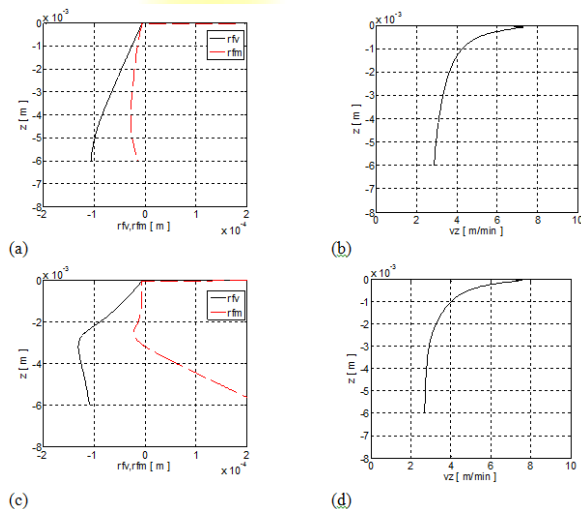


## HALO at NOLAMP 2013

The first conference on NOrdic LAsEr Material Processing (NOLAMP) was held in Oslo in 1987. At that time laser material processing was a rather new and revolutionary way to manufacture products with high quality and efficiency. The objective of the conference was to establish fruitful cooperation among Nordic laser researchers and provide a forum for young researchers to present their work and establish contacts in the scientific and industrial communities. Since then this biannual event has fulfilled its intentions and provides a useful meeting place for research and industry relating to laser technology in the Nordic countries. NOLAMP has also expanded and now attracts attendees from all over Europe.



This year the 14<sup>th</sup> NOLAMP event was held in Gothenburg on the west coast of Sweden. There were about sixty participants evenly split between research institutes and industry. The industrial participants included laser source suppliers, system builders and end users. There was an exhibition area at which HALO was represented. The HALO stand was well appreciated with a high number of visitors, fruitful discussions and a good base for further discussions!



In the session covering laser processing (including micro-machining, welding, cutting, surface treatment, tools and equipment), HALO was represented by two papers, "Modelling the cutting geometry for laser remote fusion cutting of metals," and "Measuring the state-of-the-art in laser cut quality," presented by Ramiz Matti and Jetro Pocorni respectively, both Ph.D. students from LTU.

In the first paper the state-of-the-art for remote cutting modelling and a novel approach for analytical modelling of the cutting front for remote fusion cutting were presented. This work is expected to provide important understanding of the cutting mechanism and be applicable in the development of the HALO metamodel.

The second was a presentation of the first results from the HALO industrial state-of-the-art study (see previous page). The approach for measurement, analysis and representation of two key quality indicators (edge inclination and surface roughness) was presented.

