Ultrafast_RAZipol Newsletter June 2017

Conclusioin of the project – words from the Coordinator

Having reached the end of the Ultrafast_RAZipol project our final newsletter will describe the two systems which were developed, and summarize the main test findings.

For application 1, the patterning results showed good quality with sharp edges and without damage to the glass carrier material at a high ablation rate of about 378 cm² per minute. Patterning large wafers with the HRR system using radial or azimuthal polarization enabled 78 times faster processing, compared to the benchmark application. A 50 % higher ablation rate was achieved using radial or azimuthal instead of linear polarization.

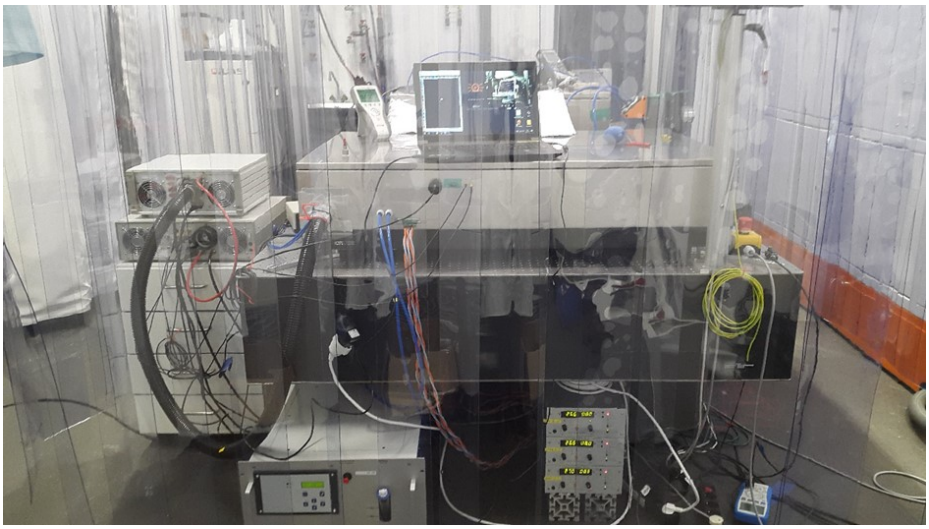
For application 2, the benchmark experiments have shown an increase of up to 50% of the drilling efficiency using beams with azimuthal polarization when compared to beams with circular polarization. Furthermore a 10 times faster drilling process is achieved when the high-power LRR developed with RAZipol is used. This leads to a processing cost reduction of a factor of 7.

I would like to take this opportunity to thank the Consortium partners for their dedication and hard work in helping the project to succeed.

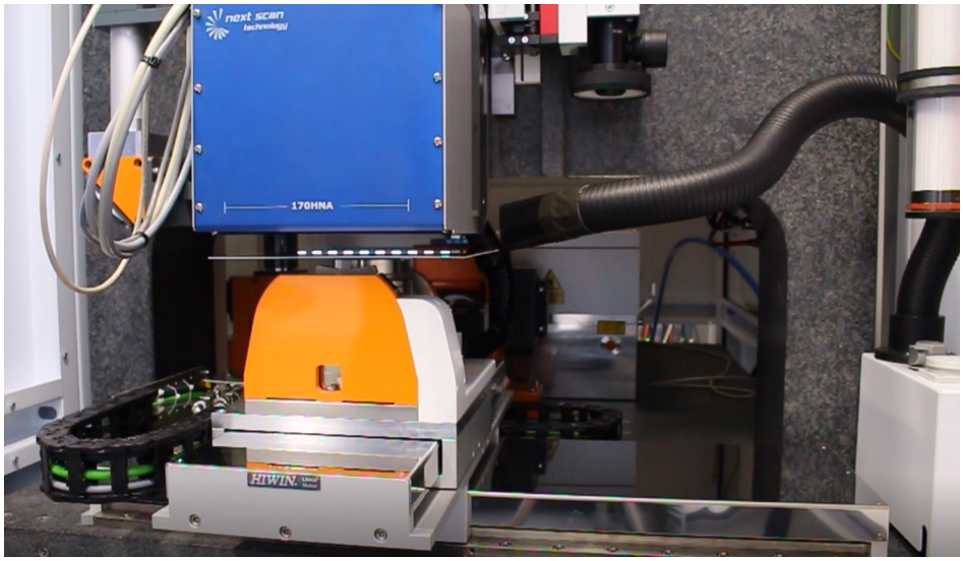
Dr Marwan Abdou-Ahmed, Head of Laser Development and laser optics Dept.at the Institut für Strahlwerkzeuge (IFSW), University of Stuttgart

The Ultrafast_RAZipol project has received funding from the European Community's Seventh Framework Programme under Grant Agreement No. 619237

The machining system with the integrated polygon scanner allows micro structuring applications on flat substrates or wafers up to 6" directly or larger sizes by stitching operation. The polygon scanner, a LSE 170 HNA, translates the beam along a line with a feedrate up to 100m/s. The second dimension is achieved by the continuous and synchronised translation of the substrate with a linear direct drive CNC axes, in the actual system the X-axis whereas the previous process development was done with two-axes-galvanometer heads with a feedrate up to 5m/s.



HRR laser layout on optical table beneath flow cabinet



System with polygon scanner in operation

The developed HRR laser can emit more than 500W with up to 20MHz pulses. In order to allow the modulation of the pulses by the polygon head, the application trials are done at 10MHz. The laser is operated at a defined power level of 320W.

The laser beam has a diameter of about 5.5mm and is expanded up to 11mm in order to fulfil the requirements concerning the desired spot size. For the LoCs, 25µJ pulse energy in a 25µm focal spot was defined to ablate the nanometer thick metal layer with a single spot.

The Ultrafast_RAZipol project has received funding from the European Community's Seventh Framework Programme under Grant Agreement No. 619237

For testing, aluminium sheets were used to be structured. Bitmaps with test layouts were downloaded to the scanner controller and executed. The controller acts as the master, requests the laser pulses and steers the transport axis synchronously. Different designs were tested.

With linear polarisation, a focal spot of 33µm was used. For the test, a hatch distance of 9µm (in-scan and cross-scan-direction) was used. The laser power used in this case was 150W @ 10.5MHz.

On 100nm Pt, with 4.2µJ the following spot sizes were achieved:

22.8µm (linear)
31.9µm (radial)
32.5µm (azimuthal)

The scan speed of 100mm/s results in 3.75mm/s axial federate

The ablation rate was considerably increased to > 600mm²/s

Machined sample

With a typical area per chip of 16 mm², per hour about 18 chips can be produced with the benchmark laser, while about 1400 chips per hour can be theoretically produced with the RAZipol HRR system. Taking into account, that several positioning steps have to be done during the processing, this leads to a processing cost reduction by a factor of 22.

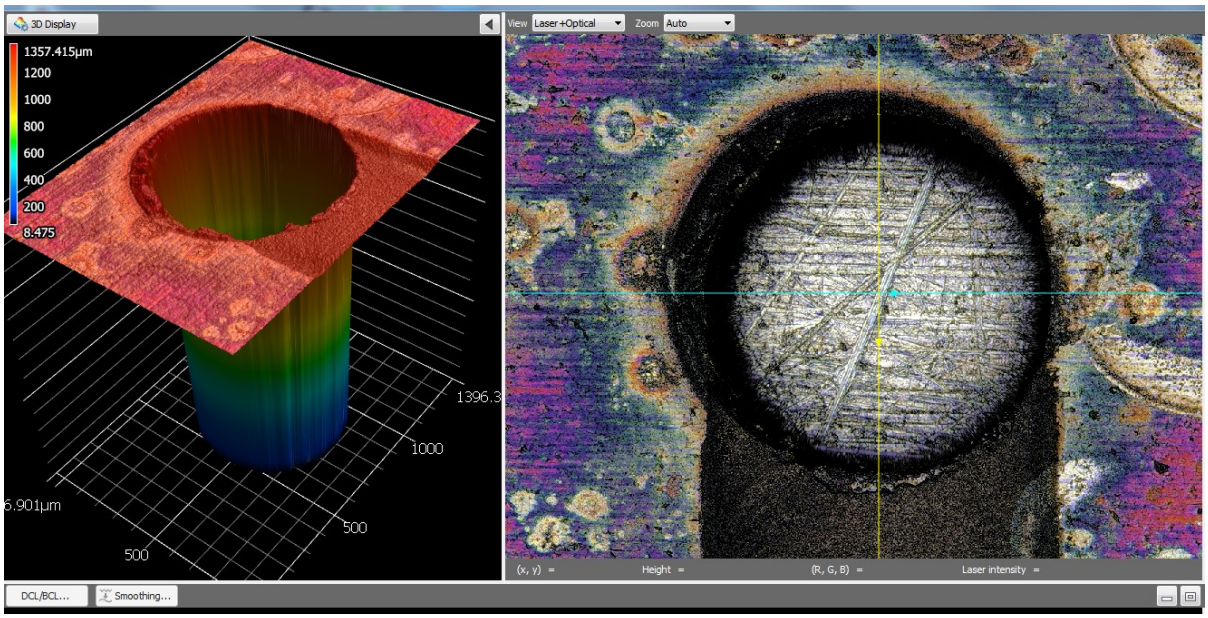
The Ultrafast_RAZipol project has received funding from the European Community's Seventh Framework Programme under Grant Agreement No. 619237

The Low Repetition Rate system has been successfully installed at the FHNW in Switzerland, with testing carried out by Class 4 Laser Professionals.

This system operates at a low repetition rate, high energy laser, for drilling of steel for automotive injection nozzle applications using a rotating optic. The main goal has been to drill 50mm holes in 1mm steel plates within less than 4 second. Parallel to this, a second goal has been set to fully benefit from the high-energy potential of the developed laser: drilling, of 200 m holes in 2mm steel plate.

The drilling time at 113 W (on working piece) has been 6.1s in 2mm steel and under 0.8 s in 1mm steel.

To demonstrate drilling efficiency of the different polarization states with the 200W laser, **percussion drilling** has been used; this shows that cylindrical polarization enables a more effective drilling for percussion drilling. Azimuthal polarization is the most effective. In 1mm steel drilling with good quality could be achieved for larger diameter. (400 - 700 µm)



Example of drilling performed with the ILT trepanning optic at 90W average power

Helicoidal drilling with drilling optic:

When drilling with the drilling optic, the efficiency of the different polarization tends to become homogeneous. Here the radial polarization is very slightly the most efficient polarization and the diameters tend to be larger for radial than for azimuthal

The Ultrafast_RAZipol project has received funding from the European Community's Seventh Framework Programme under Grant Agreement No. 619237