Ultrafast Laser Micromachining With Newport XYZ Motion System

Newport motorized XYZ sub-system, combined with an ultrafast laser, provides an edge as an advanced, high-throughput tool in micromachining

With rapid advancements in ultrafast laser technology in recent years, optical waveguide writing in bulk glass using femtosecond pulsed lasers has emerged as a powerful micro-fabrication technique in both scientific and industrial markets. A laser direct-writing technique led by researchers in the Laboratory of Physical Chemistry of Atmosphere at the University of Littoral Cote d'Opale (ULCO) in France, uses a Femtosecond pulsed laser and a Newport XYZ motion system to demonstrate increased process efficiency and higher quality of micro-fabrication results compared to conventional laser processing that employs either continuous wave (CW) or longer (> ns) pulsed lasers.

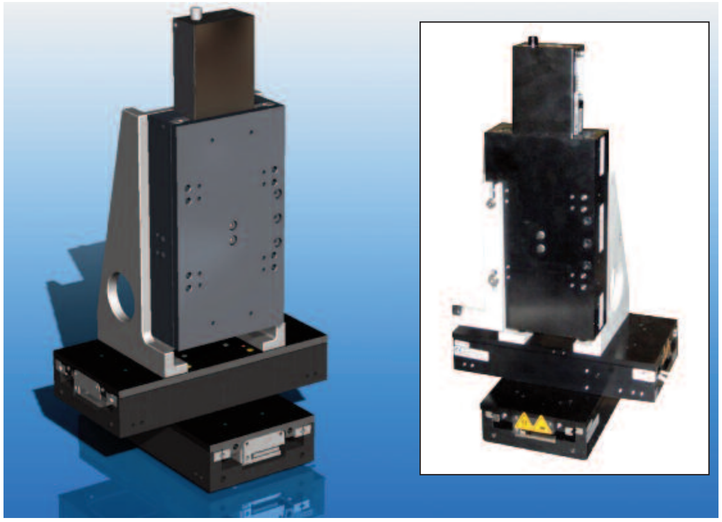

Figure 1: XYZ Sub-assembly with XMS160 (XY) and GTS150 (Z)

In order to achieve the desired results on specific materials when performing laser micromachining, one must select suitable lasers based on features such as wavelength, repetition rate, average power, and pulse duration. Ultrafast lasers are effective at machining very small, very precise patterns in tough materials as its high peak intensities lead to so-called "cold" ablation. Micro-sized structures are created with no collateral damage to the surroundings, less residual heat-affected zone (HAZ), and in some cases no material properties change. A controlled, precise micromachining process with these advantages is the reason why many in the industry explore the use of the shortest possible pulsed lasers for the most quality-stringent applications.

While the laser operating parameters are critical, selecting the appropriate peripheral instruments is also of key importance for optimizing the process to achieve high quality and high throughput microfabrication. The Newport XYZ motion system (Figure 1) used at the ULCO consists of XMS160 linear stages, a GTS150 linear stage and an XPS motion controller, and it enables the researchers to achieve significant gains in processing speed and quality during laser microfabrication of various materials including polymers, crystals, and glass. The non-contact, direct-drive linear motors of the XMS160 stages ensure high throughput motion for refractive index modifications of materials up to 300 mm/s speed and 5 m/s^2 acceleration in each axis. High precision glass scale encoders of the XMS160 and the GTS150 stages provide accurate position feedback for superior repeatability of 50 nm in XY and 200 nm in Z respectively, minimizing influences on the surrounding area during the repeated motions. Anti-creep crossed roller bearings provide excellent speed stability to minimize the local variation of pulse energy deposition as the stage moves the laser focus along the trajectory within the samples.

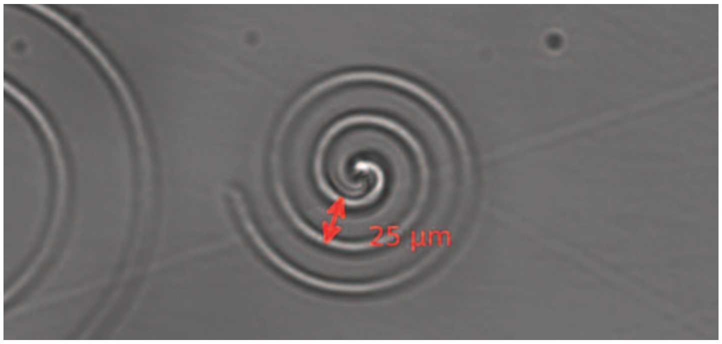

Figure 2: Optical waveguide written on a glass sample (Courtesy of Prof. Pascal Masselin at the ULCO)

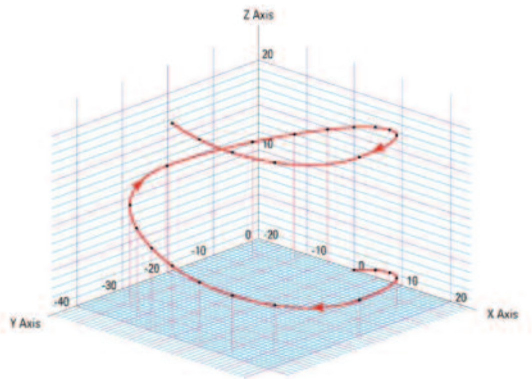

Figure 3: Trajectory path in XYZ after Spline data execution in the XPS controller

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The XPS universal motion controller provides the intuitive motion profiler and software control to achieve high throughput and high quality during the laser write process. The built-in trajectory features allow rapid change in prototyping, as the device pattern can be easily changed by simple parameter modifications. At the ULCO, Spline Cubic trajectories of the XPS controller are mainly used for laser scribe process of samples, which requires constant speed throughout the entire path or in specific trajectory elements in a three-dimensional XYZ space. Figure 2 illustrates an image of scribing on a glass sample using a Spline trajectory from the XPS controller.

Newport offers a wide array of motion control products to meet the requirements in micro-scale processing applications. Figure 4 and 5 illustrate other micromachining system solutions available from Newport. An XYZ sub-assembly from Figure 4 is constructed with a GTS150 linear stage, a GTS70 linear stage and a GTS30V vertical stage. Shown in Figure 5 is more advanced, high precision 7-axis sub-assembly utilizing XMS series linear stages, a VP-5ZA vertical stage, a custom tip-tilt-theta using motorized actuators and a custom Fine Z assembly based on piezoelectric motor.

Figure 6 represents a fully developed micro-fabrication workstation with integrated motion system, laser, vision system and laser processing control software. The Newport Laser µFAB can be provided with various types of lasers giving the user the capability to machine virtually all dielectric, conductive and ceramic materials, making an ideal solution for the most advanced research in material science and device physics.

Figure 4: XYZ Stack with GTS150, GTS70 and GTS30V for Micromachining

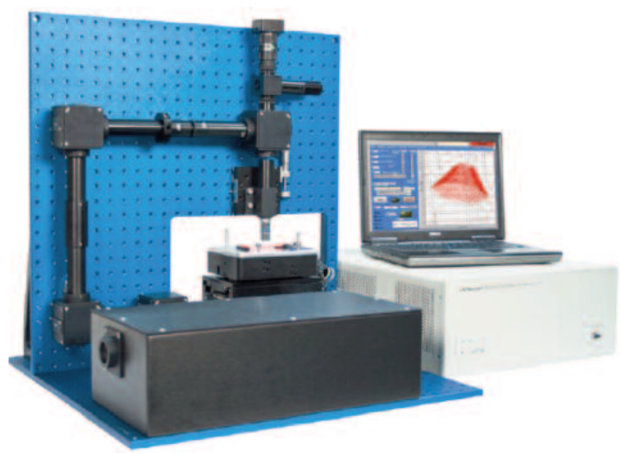

Figure 6: Newport Laser µFAB Microfabrication Workstation with XMS100 and VP-5ZA

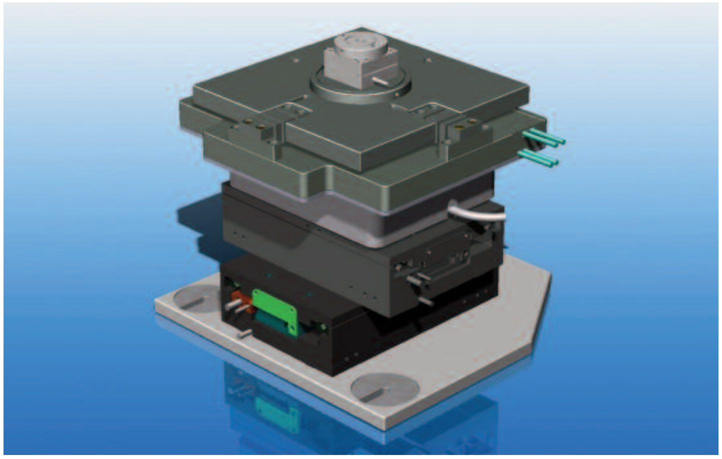

Figure 5: Custom XYZ-Tip-Tilt-ThetaZ-FineZ System for Si Wafer Positioning

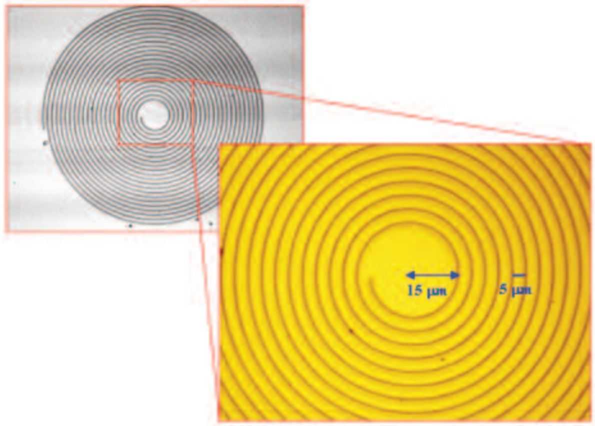

Figure 7: Spiral cut in Chromium thin films using Spectra-Physics Spitfire Pro laser (800nm, 1 kHz, 80nJ/pulse) and Laser µFAB

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Figure 7 illustrates an image of spiral-patterned microstructure fabricated with laser ablation using Spectra-Physics Spitfire Pro Laser and μFAB workstation in Newport's Technology and Applications Center (TAC).

As scientists and researchers continue to explore the advantages and potential uses of ultrafast laser micromachining further, ultrafast lasers and precision motion systems will find many more applications in the area of sub-micron material processing, photonics devices machining, biomedical device manufacturing as well as thin-film ablation and substrate surface treatments. Newport provides a variety of motion system configurations to help meet the various levels of performance and cost requirement while advancing the micro-fabrication techniques for high throughput and high quality.

For questions about Newport motion solutions please contact Newport sales and application engineers at tech@newport.com.

Newport Experience | Solutions

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