A Diamond in the Rough: Industrial Diamond Cutting and Processing with a Newport 4-Axis Precision Motion System

Diamonds have long been admired for their beauty since antiquity. In modern times, industrial applications are being driven by another property of diamonds: hardness. Their natural hardness makes diamonds ideal for a wide variety of applications from precision cutting tools to substrate for microelectronics used in extreme environments.

As with other super hard materials such as carbide, ceramic or hardened steels, diamonds are extremely difficult to cut, grind or polish due to its highly abrasion-resistant structures. Since traditional mechanical processing is often too expensive and time-consuming for these materials, alternative methods of fabrication and surface treatment have been investigated by the scientific community. Laser micromachining is a technique adapted by researchers, following recent advances in laser technology combined with increasing demand for higher quality samples. Built on a high precision multi-axis motion system, the tool that is featured in this note improves the efficiency, cost and throughput in the cutting and processing of industrial diamonds.

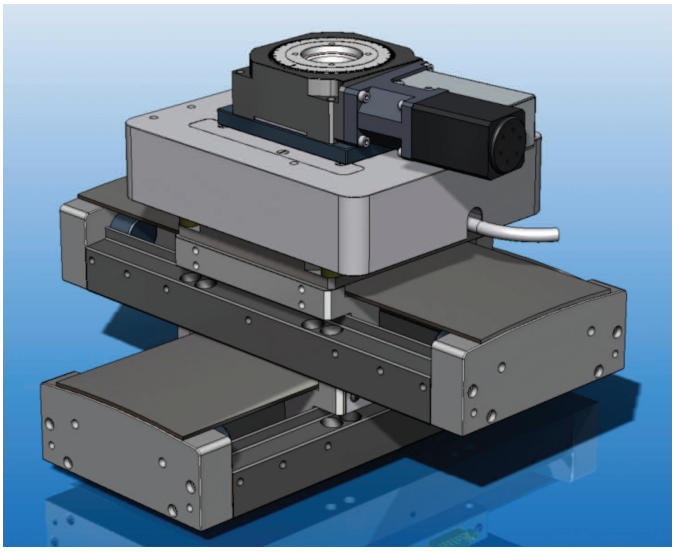

Figure 1: Newport 4-axis motion system with (2) ILS100LM's, VP-5ZA and URS50BCC

In the Department of Engineering Physics at the Nagoya Institute of Technology in Japan, researchers are using a Newport 4-axis motorized stage assembly for the advanced study of a laser processing technique for Poly Crystalline Diamonds (PCD). A high power, diode-pumped solid state laser (λ=1064nm) provides a pulsed laser output with an average power up to 12 Watts, with repetition rates between 1 to 50 kHz and pulse durations of less than 10 ns. The focused laser beam is directed into the XYZ rZ motorized assembly, producing a spot size of roughly 10 µm in diameter on the PCD sample. The motorized stack adjusts the location and orientation of the sample in and around the vertical axis, and then moves the target location in the XY axes with a range of 100 x 100 mm. The Newport assembly includes (2) ILS100LM linear motor driven stages with 500 mm/s maximum speed and 1 µm repeatability. Mounted on the XY is a VP-5ZA vertical linear stage with 4 mm travel and 1 µm repeatability and a URS50BCC precision rotary stage with 360° travel and 0.01° repeatability.

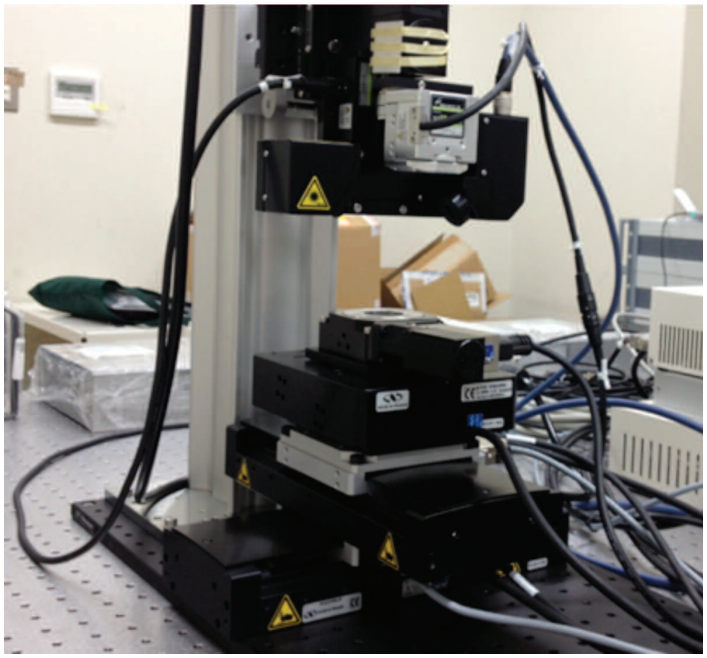

Figure 2: A photo of XYZ rZ assembly setup in Nagoya Institute of Technology

In this experimental setup, the Newport motion system addressed several unique challenges related to the characteristics of PCD materials.

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• High throughput is critical as shaping the diamonds requires polishing and removal of large excess materials: The ILS100LM linear motor stages provide up to 500 mm/s maximum speed, increasing throughput. Fully automated programs reduce manufacturing costs during the removal of large excess material and this was achieved with the scripting features of the XPS and the supplied software drivers for LabVIEW and other languages, as well as application examples.

• Special diamond tools with complex shapes require precise, distinctive profile: Advanced motion profilers in the XPS controller allows defining precise motion trajectories for multiple axes, based on position, velocity and time. The ILS-LM stages provide smooth velocity control and 1 µm repeatability at any point during a motion, resulting in high yields.

• The cost of growing synthetic diamonds is relatively high and the risk of breakage must be minimized: Newport XPS-C4 universal controller makes processing very safe since its digital trigger input and outputs allow shutter devices to start or shut off the incident laser beam precisely during a pre-programmed motion, thereby minimizing heat affected zones in the sample.

• New diamond tooling designs require flexibility for future expansion and easy integration to other devices: The XPS controller allows seamless integration of 3rd party devices including piezoelectric motors, galvo mirror heads and voice coils. In addition, XPS-GCODE software allows conversion and execution of G-Code for optimized tool path trajectories.

With the increasing market potential of PCD cutting tools, laser micromachining techniques will continue to be applied in industrial laser processing applications. Newport provides a variety of motion systems to meet the various levels of performance and to help optimize configurations for higher yield and increased throughput.

For any questions, please contact Newport sales and application engineers at tech@newport.com.

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