Cutting Laser Guided by Waterjet

During the Advanced Laser Applications Conference and Exposition (ALAC 2004) recently held in Ann Arbor, MI, personnel from Synova USA (Phoenix) presented a paper on a hybrid approach to laser cutting that uses a waterjet to guide the beam. The inventor of this process, Bernold Richerzhagen, was available to attendees during the conference.

This approach depends upon total internal reflection in a thin, stable waterjet to conduct the laser beam to the workpiece. Originally developed to reduce the heat affected zone (HAZ) near the cut, the technique also achieves absence of divergence due to light guiding, efficient melt expulsion, and efficient workpiece cooling.

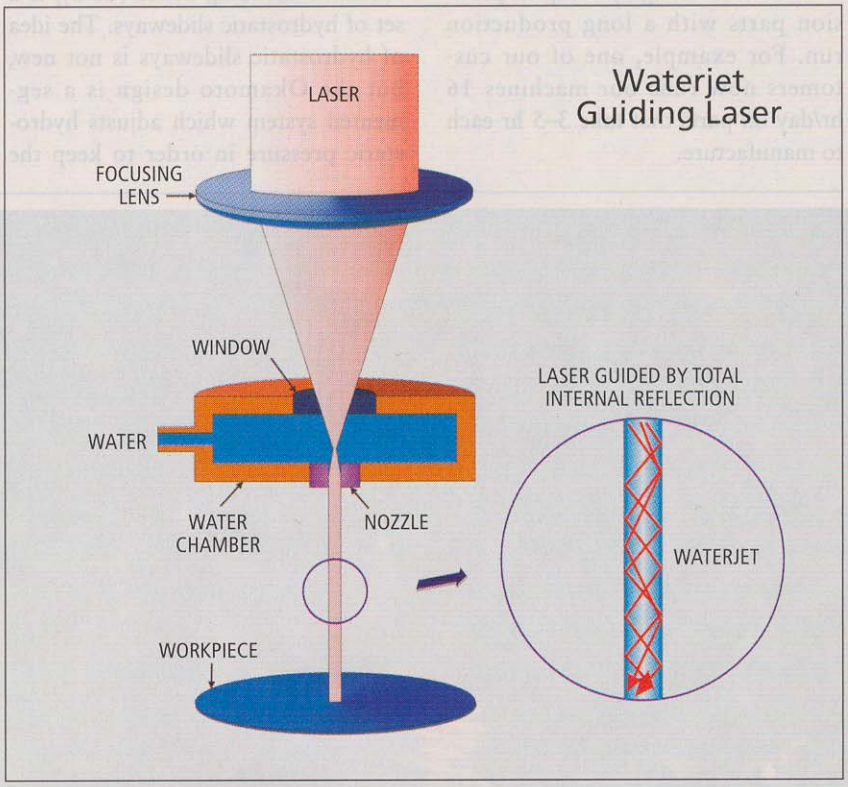
In a conventional design, coupling a laser into a waterjet causes heating where the light passes, which results in a negative refractive index (thermal lensing) and inefficient coupling. Using a waterjet to conduct a laser beam requires a highly dynamic flow in the coupling unit. Synova developed a coupling design that generates a stable waterjet due to rotationally symmetric water inflow.

The source is typically a pulsed solid-state laser operating at a fundamental wavelength of 1064 nm, or a frequency-doubled (532 nm) or tripled (355 nm) laser. Average laser power ranges from 50 to 200 W. Pulse lengths range from nanoseconds to microseconds, and pulse repetition rates range from 500 Hz to 50 kHz. The optics that image the delivery fiber onto the waterjet nozzle allow imaging factors from 4:1 to 8:1, and laser spot diam on the nozzle ranges from 50 to 12.5 µm. Conventional lamp-pumped or diode-pumped lasers can be used.

Water delivery occurs via a special pressure intensifier pump that provides constant water flow with pressures ranging from 2 to 50 MPa. Flow values are typically 5–75 mL/min. The jet length that can be used for light guiding is about 1000 times the nozzle diam, and a 50 µm waterjet can guide the laser beam 50 mm under optimum conditions. Guided by total internal reflection at the water-air interface, the laser beam completely fills the waterjet.

Laser beam diam is determined by waterjet diam, and that is constant, permitting cutting precision to 1 µm. Due to light guidance, there's no focal point, and the distance between workpiece and nozzle is arbitrary within the working distance of the jet. Consequently a distance control isn't needed, and cut quality doesn't vary with distance. Cut edges are parallel. The waterjet ejects the melt; it has much more kinetic energy than any assist-gas flow.

Using a continuous waterjet-guided laser at 600 W, researchers achieved cutting speeds of more than 4 m/sec in thin nickel foils. According to the company, there are almost no areas where waterjet-guided laser cutting does not offer improvements when compared to conventional laser cutting. Synova USA is a subsidiary of Synova SA (Lausanne, Switzerland). For more information Circle 201 or go to Synova's Web site at www.Synova.ch/.



Key to using a waterjet to guide a laser beam is avoidance of thermal lensing.