Air Liquide
Bifocal Mirror By-Line

Bifocal Mirrors Increase Efficiency for Fab Shops
Lasers equipped with dual-focus mirrors help shops cope with increased demand while improving quality and the bottom line.

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Until recently, dual-focus effect was only achievable by replacing a standard focusing lens with a bifocal-focusing lens. After years of development, a new dual-focus technology has been successfully tested and is now available for high-power CO_2 laser cutting. This newest application uses a bifocal mirror, which in combination with a standard lens, yields a dual-focus effect. This combination has led to double-digit increases in production cutting speeds particularly, when laser-cutting stainless steel, galvanized steel or aluminum under high-pressure nitrogen-assist gas. The mirror is unique because it is effectively protected from sputters projected from the point of cut and is constantly water-cooled to prevent overheating – a costly problem with traditional lens applications. This insures a long mean time between cleaning and a long life for the bifocal mirror. In addition, the new mirror technology makes cutting 20 to 30 percent more efficient than traditional methods; thus, allowing more throughput and requiring less overtime.

Bifocal Mirror Technology

The BIFOCAL process, which was originally invented in Denmark, belongs to Air Liquide. Air Liquide carried out extensive research and product development before bringing the product to market. During development, the company discovered that increasing production speed results in higher profitability and lower variable costs in

such areas as labor, supplies and maintenance. These advantages can translate into significant annual savings for companies.

Bifocal mirror technology delivers stability to the operation by employing a dual-focus mirror with two focusing points along the beam pointing direction. Upon incidence on a standard focusing lens, the outer part of the laser beam reflected from such bifocal mirror will propagate through the focusing lens of focal length ***f*** and forms the first focus point, while the inner part of the same laser beam will propagate through the focusing lens as if it had a focal length ***f+df*** and forms the second focus point at a distance ***df*** below the first one.

During cutting, the top focusing point is positioned near the top surface of the material. The second focusing point, obtained from the smaller convergence angle, is positioned near the underside of the material. The focus point located near the underside of the workpiece works to avoid dross formation, while the other focus point, located near the upper surface, produces a high enough power density near the top surface to boost cutting speeds.

A number of laser job shops are already using the technology, including Fab 2 Order which specializes in manufacturing original equipment manufacturer (OEM) parts from medical to material-handling applications.

Technology in Practice: Fab 2 Order Realizes Significant Gains in Efficiency with Minimal Interruption

Fab 2 Order is a very flexible and highly diversified metal fabricating and welding shop in Indianapolis. Fab 2 Order uses Air Liquide's BIFOCAL mirror technology on its 2002 L3030 3200 watt Trumpf laser cutting machine. The company works primarily with mild steel, stainless and aluminum, at thicknesses ranging between .015" and .750". With 18 employees and 2007 revenues of $3.9 million, efficiency and accuracy is at the heart of Fab 2 Order's operation.

The management at the company chose the technology based on the results of a demonstration performed at its facility. This demonstration showed that Fab 2 Order could realize performance gains between 10 and 60 percent depending on the type and thickness of the material.

Upon implementing the BIFOCAL technology, Fab 2 Order laser operators worked directly with an Air Liquide training technician onsite. This allowed Fab 2 Order laser technicians first-hand experience to implement equipment set-up changes and understand the effects of the technology when cutting different materials.

Fab 2 Order has realized production gains across the board and has noted a significant reduction in gas consumption due to increased production capabilities and reduced part costs. The most notable achievement was the ease of implementing the technology. The implementation of the BIFOCAL technology was non-invasive, acceptance by the operators was very smooth, and there was no change in their normal operating procedures. Fab 2 Order management cites that support from Air Liquide is quickly available, but rarely needed.

Figure 1: Jason Greeson, Fab 2 Order, with a piece of .357” thick 5052 Aluminum cut at 16” per minute. This represents a 78 percent increase over stock parameters for a 3200W Trumpf.

Figure 2: Two focusing points are better than one, allowing the operator a cleaner cut.

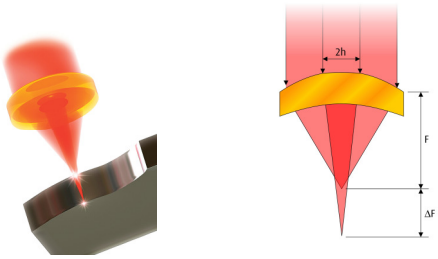

Figure 3: ¼" Material cut with Bifocal Mirror at higher speed and higher edge quality.

AL = Aluminum; MS = Mild Steel; SS = Stainless Steel

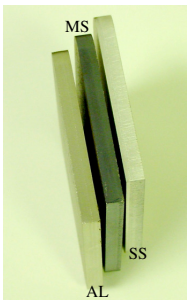

Figure 4: Bifocal Mirror vs. Bifocal Lens: The dual focus effect can be obtained by either combination.

[standard mirror + **Bifocal lens**]
or
[**Bifocal mirror** + standard lens]

		
Bifocal Optics Consumption	Low	High
Performance with High Power Laser	High	Low
Bifocal Optics Cleaning Frequency	Low	High
Bifocal Optics Cost to End-User	Low	High

Figure 5: Comparing production cutting speed between standard optic versus Bifocal mirror: Average speed gain of 35 percent on this Trumpf 5kW laser cutting machine.

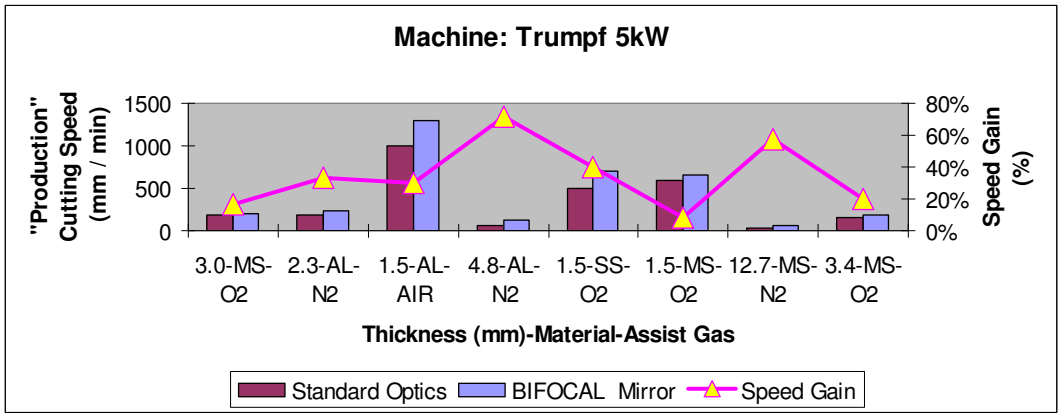

Figure 6: Comparing production cutting speed between standard optic versus Bifocal mirror: Average speed gain of 23 percent on this Bystronic 2800 W laser cutting machine.

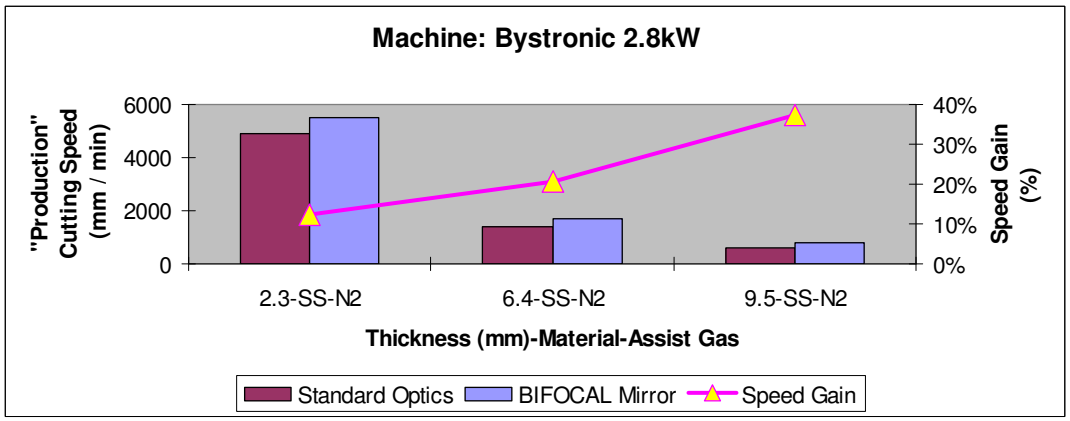

Figure 7: Comparing production cutting speed between standard optic versus Bifocal mirror: Average speed gain of 28 percent on this Trumpf 3 kW laser cutting machine