Laser Manufacturing Expands Its Reach

There are at least two factors that are making lasers more attractive than ever for cutting, welding, and other material processing tasks. One is increasing power and the other is their improved ruggedness, according to Jim Rogowski, director of machine & power tool sales for Trumpf (Farmington, CT).

More power means more productivity, cutting thicker materials or cutting the same materials faster. “Power will always continue to grow, especially in cutting applications,” he said. Just a couple of years ago customers were primarily cutting up to 1” (25.4-mm) thicknesses, but now he is seeing applications cutting up to 2” (50-mm) thicknesses of materials like stainless steel.

Lasercoil has seen fiber lasers improve so much in the past five years they are now offering laser blanking systems producing volumes of 50,000–70,000 parts per year economically.
More reliability means these once delicate systems can live in work-a-day shops and challenging environments. “Lasers that process plate metal and sheetmetal could be sitting next to doors that open to winter weather and run automatically,” explained Rogowski. “This is enabled by reliability enhancements that have improved in just the last two years.” Enhanced automation features are growing as well. He listed options from Trumpf that automatically center beams of CO₂ lasers using sonic waves, nozzle changers that automatically change nozzles, and single cutting heads for all sheet ranges in different applications.

While he believes CO₂ lasers will remain in the market, “the big advancement in just the last few years is the introduction of solid-state lasers,” said Rogowski.

Rise of Solid State

Tom Kugler, fiber systems manager for Laser Mechanisms (Novi, MI) agrees about the importance of the rise of solid-state disk and fiber lasers. While CO₂ lasers were once the only practical choice for heavy-duty laser processing applications like cutting and welding, these newer solid-state lasers offer advantages in power, efficiency, and materials they can cut. “Like the old Nd:YAG solid-state lasers, their light is roughly 1 µm in wavelength,” he said, as compared to the 10.6-m wavelength light of CO₂ lasers. One-micron beams can be delivered via fiber-optic cables, a convenient way to move and mount laser energy compared to the optics and mirrors required of the far infrared CO₂. The 1-µm wavelength is also absorbed better by more materials, especially nonferrous metals like copper and brass, expanding utility.

He also notes that these newer solid-state lasers boast efficiencies of 30% or more. While this helps with electricity costs, there are other practical advantages. “For lasers up to 500 watts, you can buy air-cooled lasers, which simplifies their use and lowers their cost. There are a lot of processes done in that 100–500-watt range,” he said.

What applications could benefit the most from these newer solid-state lasers? He reports seeing more instances of lasers performing 3D cutting, equipped on multi-axis robots and CNC-guided machine tools. “[Solid-state lasers] are also definitely making their mark in the flat sheetmetal market,” he added. “These used to be all mounted with CO₂ lasers. In the last three–four years, solid-state 1-µm lasers are showing they are faster in thin metal, up to three times faster in 1–2-mm-thick metal sheets, especially in aluminum or polished stainless.”
He also observes that CO₂ lasers still dominate cutting thicker materials, about 3/8” thick or thicker (>9.5 mm). This is because of the complicated physics of how materials absorb different wavelengths, with better absorption from a 10.6-m beam at the low angle the laser strikes the cut front, according to Kugler.

**Automation Keeps Up with High Mix and Low Volume**

Jason Hillenbrand, product manager for Ama- da America (Schaumburg, IL) notes that lasers have another fundamental advantage to offer—versatility. “Lasers material processing is always adopted by addressing the most common problem in manufacturing—the high-mix/low-volume scenario,” he said. He sees the entire spectrum of manufacturing and fabrication adopting more laser material processing because of this. “Our customers need to address quick turnover in rush jobs, which is why programmable laser equipment is so important to them,” he said. “They cannot wait a week to get parts to potential customers, they will lose the business.”

There is also the continuing push to reduce inventory and work-in-progress, just as important to large OEMs as to small job shops. “OEMs also assemble parts into kits [for later assembly]. They need to put together an entire assembly that contains mixed materials and thicknesses.” A single laser system programmed for all the parts of a kit, suitable for all of its materials, is ideal. That’s because it requires no special tooling, just some new programming—as long as the material is suitable.

**Short-pulse lasers are ideal for precise, small holes such as those needed for today’s gasoline direct-injectors that measure a few hundred microns in width. An example is shown in magnification here.**
He also notes that as lasers are getting more rugged and cutting faster, the integrated, automatic systems they live in must improve as well. "It puts a major strain on automation because the new lasers, especially fiber lasers, are so much faster. As a result, the downstream process has really been challenged," he said. "We have increased speeds and new features on our material handling automation to address the faster process time of lasers."

**Laser Moves to Automotive Production**

High-speed laser blanking from LaserCoil (Toledo, OH) is a case in point where laser is encroaching into a field dominated by a traditional process, in this case die blanking. "Originally we were looking at using a 1–2-kW laser to cut sheets that were 0.5–2.5-mm thick," explained Jay Finn, applications engineer for LaserCoil. "Cutting speeds then were 20–30 meters per minute." This was suitable for a system that could perform limited special service or prototype work.

However, their plans were overtaken by developments. Over the past five years, costs have gone down and cutting speeds have grown exponentially. They could purchase a 4-kW laser today for the price of a 2-kW fiber laser five years ago. Their vision to create a device for a coil-fed, laser-blanking system quickly changed. "We are looking at production today," said Finn, "with a system producing significant volumes of 50,000–70,000 parts per year economically."

It is not just speed or cut quality where laser offers an advantage, though both matter. "For the material that we cut, lasers certainly offer better quality ... Since you are not mechanically shearing the edge, there are none of the micro-fractures produced in the laser-cutting process, that are typically produced in mechanical shearing," Finn said. This is especially important as the automotive industry begins using more high-strength steels (HSS) and advanced high-strength steels (AHSS) to reduce weight and improve fuel
Laser die-blanking is solving the problem of micro-fractures often seen in these harder materials when cut with die-blanking presses. “These micro-fractures increase the likelihood of a split during the subsequent draw process and this potential for defect is simply not present with laser cutting,” he explained. Aluminum is another material automakers are looking at adopting that a 1-µm fiber laser can easily cut.

While Finn is pleased with the current speed and capabilities, he sees future improvement. He anticipates the day when laser power will be even more economical. “Our laser gantry system is designed for the integration of a 10-kW laser. We are serious about someday building a laser-cutting system that will go faster than a mechanical press,” said Finn.

Companies like Amada are still improving the 1-µm fiber laser. Its ENSIS fiber technology, for example, not only processes thin materials very fast—which has been the strength of fiber lasers—but it also processes thick plate with the same speed and quality that higher wattage CO₂ machines can do. Hillenbrand from Amada believes this is revolutionary. “We are now cutting plates as thick as 1” mild steel with a 2-kW fiber laser with quality comparable to a 4-kW CO₂ laser,” he said. The first installation in the ENSIS-3015AJ system adjusts the beam configuration automatically to cut different types and thicknesses.

Trumpf is also improving the capabilities of its solid-state lasers. The company is now offering its TruLaser 5030 fiber with its new BrightLine fiber function that
cuts stainless steel up to 1" thick. The BrightLine fiber also enables the laser to produce small holes and tight contours in thick sheet metal with better exceptional cut quality and productivity in mild steel in the ½–1" (12.7–25.4 mm) thickness range, according to Trumpf.

For the future, there are two developments in lasers that bear watching, according to Rogowski from Trumpf: direct-diodes and short-pulse lasers. “We use 0.96-μm diode lasers to pump resonator material in our disk and fiber lasers, which produce beams more useful for cutting and other applications,” he explained. Skipping the resonator device and using the diode directly would be an even more efficient laser beam, greater than 50%, with an even smaller footprint. Currently, beam quality of direct diodes is 8–10 times worse than that from solid-state lasers, which limits their utility in cutting. But each year brings improvements and they have produced excellent quality and speed for applications in welding and cladding operations.

The other trend to watch is the short and extremely short-pulsed lasers. These are in contrast to continuous-wave lasers in that they concentrate high power in very short bursts of energy, which has many advantages. ME

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