LASER REFLECTIONS

How fiber laser users are successfully processing highly reflective metals

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High-power fiber lasers are revolutionizing industrial materials processing markets by offering an unmatched combination of performance, reliability and cost advantages. For example, in sheet metal cutting, fiber lasers provide the highest cutting speeds and the ability to process thick sheets (more than 1 in. thick) for a range of metals with a single tool.

Along with low power consumption and high reliability, these capabilities result in the lowest cost per part. This is why fiber lasers have been the fastest-growing segment of the laser market for the past decade. This trend is continuing as fiber lasers displace legacy laser and non-laser technologies in existing welding and cutting applications and enable new applications that cannot be addressed with previous technologies.

Although deployment of fiber lasers has increased, users have identified shortcomings of the conventional fiber laser architecture, including sensitivity to back-reflected light, which can cause frequent process interruptions, preclude processing certain metals and finishes, and result in laser instability or damage. Users have also identified limited serviceability as a shortcoming, which can cause excessive downtime and service cost.

A new generation of fiber lasers, however, addresses these limitations with high-performance components and a novel architecture to enable uninterrupted processing of highly reflective metals and maximum uptime.

Addressing back reflection

To solve the problems found in legacy fiber lasers, nLight Inc. released its alta fiber lasers, which address the need for back-reflection protection as well as modularity and serviceability. To overcome the issue of back reflection, the alta lasers have a robust, integrated back-reflection isolator to protect the laser system from back reflection generated by the workpiece or other components.

Legacy fiber lasers, on the other hand, often employ “software isolation,” which shuts off the laser when back reflection is detected. While the software isolation approach may protect the laser from damage, it precludes successful processing of many materials.

Furthermore, legacy fiber lasers may be destabilized by back reflection. Although the laser doesn’t shut off in this case, the process can become unstable or irreproducible. In contrast, nLight’s “hardware isolation,” converts the back-reflected power to heat, which dissipates before it can damage any components or destabilize the laser.

To ensure alta fiber lasers would not experience instability, shutoffs or
Conversely, alta fiber lasers have an architecture that houses the pump diodes and drivers in standalone pump modules and the gain fibers in a configurable gain module that can generate more than 4 kW of output power. As a result, service tasks can be accomplished quickly (in less than two hours) in an industrial environment using relatively simple equipment and procedures.

Likewise, service can be performed directly by tool integrators, enabling them to ensure prompt and efficient support of the end user. Finally, the novel architecture enables advances in diode pump sources (the component experiencing the most rapid innovation) to be incorporated rapidly with minimal design ripple.

**Cutting, welding results**

Deployed worldwide in industrial tools, nLight is able to validate the advantages of its next-generation systems. They have demonstrated high-quality cutting and welding.

**Laser architecture**

Legacy multi-kilowatt fiber lasers are comprised of multiple, lower power fiber lasers where outputs are combined; the fiber laser building blocks typically operate at 500 W to 1,000 W, with more recent models reporting up to 3 kW. This architecture has several drawbacks, including redundancy of complex and expensive components among the fiber laser building blocks, lack of serviceability in a manufacturing environment, and the need for highly sophisticated service personnel and equipment.

A 1-kW fiber laser sustaining 1 kW of continuous laser light back reflection, and copper piercing (4,000 continuous pierces). Damage, they were tested with up to 1 kW of power continuously back reflected into the laser. This is a much higher level than observed in real-world applications.

Processing of up to 1-in.-thick mild steel, stainless steel, aluminum, copper and brass (left to right).
The only fiber laser source for highly reflective materials processing.

- Highest uptime with the lowest cost of ownership
- Stable processing of polished stainless, aluminum, brass, and copper
- Most versatile laser, now available up to 8 kW

Upgrade today.
of a variety of materials, including uninterrupted processing of highly reflective metals and finishes, and high uptime in harsh environments.

Sheet metal cutting typically generates back-reflected light in short bursts when piercing or during process deviations, such as loss-of-cut or focal shift situations. Welding generates more sustained back reflection because the laser beam does not penetrate through the workpiece.

In both cases, processing highly reflective metals, such as aluminum, copper, brass, silver and gold, or finishes, such as mirror stainless steel, has been particularly problematic for legacy fiber lasers. According to users, the problem is eliminated by alta fiber lasers, which are routinely used to cut these metals without interruptions.

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Likewise, in welding applications, which generally produce higher or more sustained back reflections than cutting, no laser instability or damage has been observed. This is the case even while welding at normal incidence.

These results can be seen in image A, which shows an example of continuous deep-penetration copper welds; in image B, which shows a copper/aluminum cap weld used for electric vehicle battery production; and in image C, which shows cross sections of a copper weld, achieving consistent results requires high power stability and tunability. The overall results illustrate the importance of back-reflection protection and laser stability for advanced welding applications.

Because of their innate technological advantages and rapid innovation in component technologies, fiber lasers offer unprecedented performance, reliability and cost of ownership. But, next-generation fiber lasers are driving even wider adoption in established applications as well as in advanced and emerging applications.

That increased adoption is thanks to their immunity to back reflection, high power stability and tunability, and unique serviceability. With these features, alta fiber lasers enable uninterrupted processing of highly reflective metals and finishes with high uptime and low cost of ownership.