Development and Validation of Laser Welding Processes at the Academy and Research Center for Welding Technology - SLV Munich

Peter Limley is used to offering external support to companies looking at developing and validating demanding laser welding processes. A range of ROFIN lasers are available at the SLV Welding Training and Research Institute; including the Integral and Performance; these machines are available in various test laboratories, and open up all conceivable possibilities for evaluation and validation of manual and automated welding processes to the laser welding expert. The ‘SLV Munich’ in Bavaria which employs 85 people is the largest of eight academies and research centers in Germany, which are associated with GSI mbH. Their main focus is on providing a consultation service for differing welding techniques; in addition they provide a comprehensive range of training programs. Customers come from varying industries, ranging from steel processing, the medical device industry, and the Max-Planck Institute for Plasma Physics.

Canulated screws for spiral column stabilization

The Performance, Select and Integral form part of the manual laser welding family from Rofin. These machines are designed to be used as manual machines and can also be run as CNC-controlled laser welding systems. The machines stand out due to their versatility; and are therefore widely-used in the medical device manufacturing sector. This is why new products from this sector end up on the desk of Peter Limley; one such example is the latest product from Ulrich Medical in Ulm. The medical device specialist has been working on the development of a new generation of their cosmic™ screws for dynamic stabilisation of the spinal column. With differing forms of degenerative deformations of the spinal column, neither an intervertebral disc prosthetic implant, nor an Albert-Delbee operation is always first choice. In these cases, the dynamic rod-screw system is an elegant alternative to sustain the mobility of the spinal column.

The fundamental part of the cosmic™ concept is a hinge joint between the bolt head and the thread. To increase the precision and safety of screwing implants into vertebrae, Ulrich Medical canulate the screws, i.e. they apply a central drill hole. In this way, the position and the angle of the screw channel can initially be fixed with a thin guide wire allowing precision positioning of the screw. The rivets on both sides of the end-to-end connection pin (which has been used to date), may have been in the way of the new hollow screw.
Precision laser weld serving as redundant safeguard

Official approval of the implants in the medical device industry calls for redundancy safeguards for central body functions. The press fit of the two intricate bolts; (with a diameter of 1.5mm and a length of 3mm) connecting the screw with the half-shell is not sufficient; so a laser weld acts as a redundancy safeguard to protect against the parts becoming loose. All parts are made of a titanium alloy. In addition, a small gap has to be welded as the drill holes are a slightly larger diameter to act as an assembly aid for insertion of the bolts.

Developing the ideal laser welding process

After putting the components into the fixture the CNC controlled welding process creates the required circular seam weld. Peter Limley sets and refines the relevant values for the voltage, pulse width and pulse energy to ensure that during in house testing the work-piece has a penetration depth of 0.4mm without any micro-cracking or other weld defects. The laser parameters are able to create a seam weld which is approx. 500 microns wide, and which have a significantly minimized heat affected zone.

As the customer will use a ROFIN laser welding system which is identical in specification to the machine at SLV Munich, the transfer of the welding process into the production environment will be remarkably easy.

Metallographic evaluation for validation

The metallurgical evaluation of the weld is conducted in the first instance by taking cross sections. Looking through the microscope, the ground and polished cross sectioned surface allows the exact identification of the position and depth of the weld; as well as any structural modification of the material. Additionally, the evaluation of various test samples demonstrates the process reliability and component variation.

Dye penetration tests will identify the absence of micro cracks and porosity. This established technique uses a colored penetrant with good creeping abilities to identify any defects. If there are any defects, these are easily identified as penetrant remains on the surface after cleaning, and even the smallest fissures with widths of 1 micron are identifiable.
Finally hardness tests establish the increase in material hardness at the weld seam compared to the hardness in the base material. The metallographic evaluation of the samples produced at Ulrich Medical and tested by SLV Munich show consistent welding results and no defects at all. This is an important prerequisite for the approval of the new screws for the medical device industry.

**Integral with more laser power and validation support**

Meantime, the hollow-drilled cosmic™ screws have become established as an alternative solution for the dynamic stabilization of the spinal column. ROFIN’s new Integral with 200 watts has now replaced the Performance as the most frequently used laser welding system at the SLV Munich. Featuring the high power, and the appropriate pulse stability of the new laser resonator, the system is particularly suited for welding of complex materials, and material combinations such as aluminum and copper. This fact is most important to the SLV as their main focus – besides training - is on particularly demanding and crucial welding tasks.

The new laser welding system is suitable even for process validation. The process related welding parameters can be monitored, filed in log files and documented in order to verify a reliable process. The combination of manual feeding and CNC control designed around the requirements of the laser welding process, give high levels of flexibility and a dependable production tool.

**Fig. 1:** Cross section for validation – weld without any micro cracks and fissures welded with a ROFIN laser

**Fig. 2:** Finest weld seam which can be detected only at a very close look with a naked eye
Fig. 3: Hollow-drilled cosmic™ screws as an alternative solution for the dynamic stabilization of the spinal column

Contact ROFIN-BAASEL Lasertech:
Marketing Communications
Susanne Lötzsch
ROFIN-BAASEL Lasertech
Phone: +49-(0)8151-776-4280
e-mail: s.loetzsch@baasel.de

Contact SLV Munich:
Peter Limley.
Schweißtechnische Lehr- und Versuchsanstalt SLV München
Niederlassung der GSI mbH
Phone: +49-(0)89-126802-55
e-mail: limley@slv-muenchen.de