Laser welding

puts injection mould tools back into production

Laser welding is now a well-established industrial technology with a track record of more than 25 years in various industrial applications around the world. In the tool and mould-making industry however it is still relatively new, having first been applied less than 10 years ago. Dave MacLellan – Laser micro sales manager, Rofin-Baasel UK – presents the case for using the process for mould tool repair.

Rofin, a leading global supplier of industrial lasers, supplies a complete range of pulsed YAG lasers for welding mould tools. These are suitable for applications from small inserts to large automotive tools weighing several tons.

The StarWeld Tool family of laser systems is being used around the world for welding stainless steels, tool steels, titanium, aluminium and copper alloys. The addition of welding filler wires allows the build-up of areas and edges on worn, damaged or incorrectly machined tools. *Figure 1* shows the StarWeld Tool Open system – a turnkey laser welding system. It comes with a built-in water chiller and laser optics carried on motion axes sited at the end of a long-reach cantilevered arm. Since the laser beam is moved over the tool, there is no limit to the weight of tool that can be welded. In the case of very large tools, the Tool Open system can be used as a mobile unit on-site – a solution with minimum set up time and maximum flexibility. Although the European market has adopted this technology very rapidly, there is not yet a local service in South Africa offering sub-contract laser repair.

Why laser weld repair?

With the increasing volume of cheap mould tools manufactured in remote areas using low cost labour, there is a growing requirement to be able to modify or repair tools locally – avoiding the cost of shipping large tools around the world. Most commonly, tools will either be worn or damaged, though sometimes they need to be welded because too much metal has been taken off during manufacture or there is a late design change. A logo or some text may need to be altered for example, which can be done by building up the mould using filler wire and re-machining.

Without welding as a repair solution, the alternative is to remanufacture an insert or several inserts – a lengthy and costly process. To overcome the shortcomings of remaking tools, there is a network of specialist welding companies who are starting to address this requirement. Toolmakers with a large tool-room can also often justify the investment in their own laser welding system. Tools can be repaired by laser 'while you wait', allowing the shortest repair times and minimum downtime for the moulding tool.

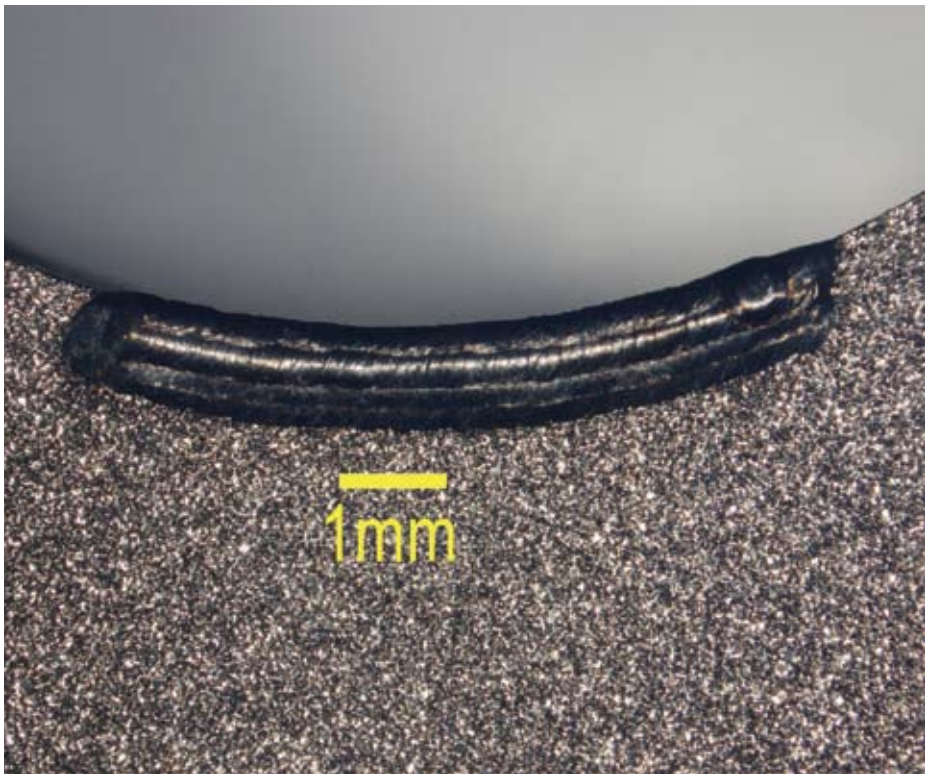

Figure 2: An H13 mould repaired by laser welding.

Finer than TIG

Laser welding offers many benefits over traditional methods of weld tool repair – TIG and Plasma – and is becoming the method of choice for tool repair in the injection mould, blow mould and die repair markets. The quality and consistency of laser welding enables novice welders to achieve welding results that would require decades of experience from a TIG welder. Where fine welding is required or fine features on a tool need to be repaired, laser welding enables the repair of tools that would otherwise be scrapped. Very fine wires – down to 0.1 mm diameters – can be deposited and the accuracy of placement of the laser weld – assisted by the use of a microscope – shows exactly where the laser beam will weld. In most cases, if you can see the place you need to weld, the laser will be able to weld it, even down the insides of bores or in partially obscured regions. The non-contact nature of laser welding avoids the risk of material from an electrode contaminating the material being welded, and also means that tip sharpening or replacement is unnecessary. The ongoing

Figure 1: The StarWeld Tool Open manual laser welding system.

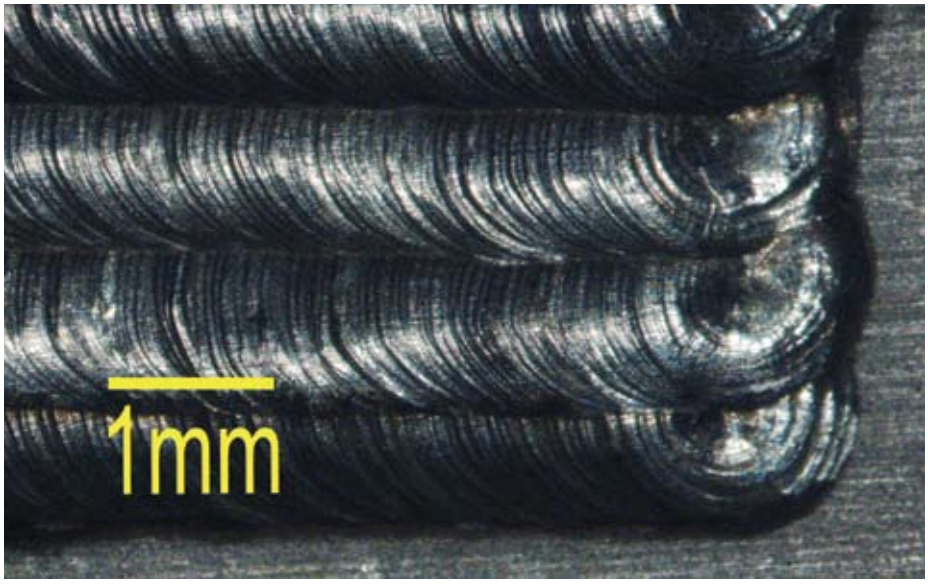

Figure 3: An aluminium mould repaired using 4047 filler wire.

cost of running a laser is also very low. The machines are rugged and reliable, needing minimal attention.

Tool steels

Common steels used in the manufacture of mould tools are selected for their hardness, wear-resistance and long life in production. The most common steels used for plastic injection mould tools are H13 (1.2344); a hot working steel with 5% chromium content, P20 (1.2311); a pre-hardened high tensile steel and 420 stainless steel (1.2083), which can be polished very well and is resistant to attack from corrosive plastics. All of these materials can be laser welded using filler wires of similar alloy composition to achieve high hardnesses and polished finishes. *Figure 2* shows the laser repair – before finishing/polishing – of the rounded edge on a tool for an electric razor made from H13 steel.

The damaged edge has been repaired using an H13 welding wire with a 0.4 mm diameter applied by hand. Five passes have been used to build up the edge. After re-polishing the repaired edge has similar hardness – 58 HRC – to the original tool. The laser weld exhibits no porosity or sinking and the overall cycle time for welding is under 30 minutes. The TrackMode™ on the Rofin laser enables non-linear weld geometries to be set up using the teach function, whilst SynchroWeld™ ensures consistent pulse-to-pulse overlap to give a weld bead with a regular height on a complex path welded at varying speed. These features enable welds of excellent quality to be achieved with minimal training and experience.

Aluminium tools

Blow moulding tools – plastic bottle moulds for example – are often made from aluminium alloys. Mould tool wear is typically seen at the sharp edges and sometimes impact damage can cause surface deformation. The result is poor quality moulded parts.

The laser welding of aluminium requires higher laser pulse energy since the material reflects a large percentage of the laser beam. The choice of an appropriate welding wire is also very important. In the example shown in *Figure 3*, a surface has been built up using a filler wire in 4047 aluminium alloy with 12% silicon content. This minimises the risk of cracking when repairing a low silicon aluminium alloy tool made from say 6061 or 6082.

Without silicon in the weld metal, the partially solidified weld zone cannot withstand the stress of solidification shrinkage. This leads to solidification or hot cracking along the centre-line. Under a microscope you can see that the deposit of 4047 shown in *Figure 3* is free from cracks and has a layer height of approximately 0,3 mm as compared to the welding wire diameter of 0,4 mm.

Laser welding wires

The most typical diameters for laser welding are in the range of 0,2 to 0,6 mm in diameter. Expert advice and a range of laser welding wire consumables suitable for laser tool repair can be obtained from Rofin.

Training is essential to enable the novice laser welder to get up the learning curve as rapidly as possible. Usually, with four hours training and a few weeks practice, the trainee laser welder can tackle most repair tasks with confidence.

Support for Rofin laser products and applications in South Africa comes from Applied Laser Power (ALP), contact Hofmeyr Brand on 021 854 7482 / 083 644 0494 or email hbrand@wol.co.za