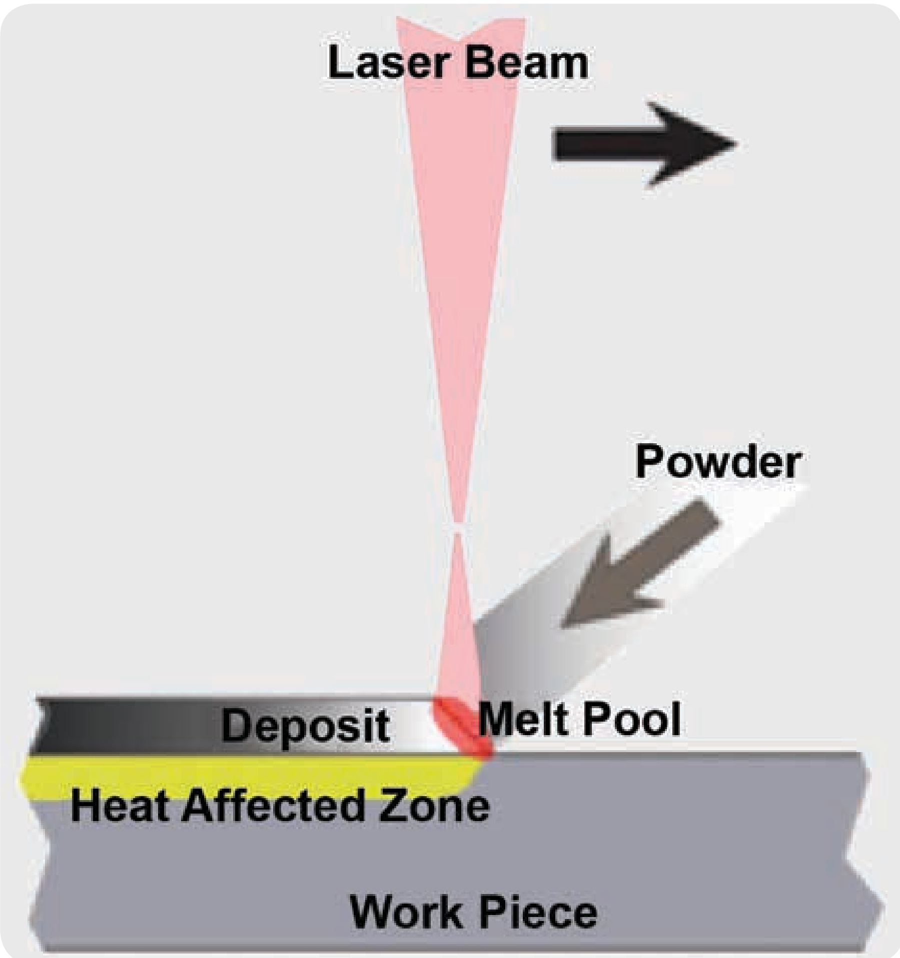
Coating specialist adds laser cladding capability

Thermaspray has installed a purpose-built laser-cladding booth to its coating facility in Olifantsfontein. The company's managing director, Jan Lourens, introduces the technology and its advantages.

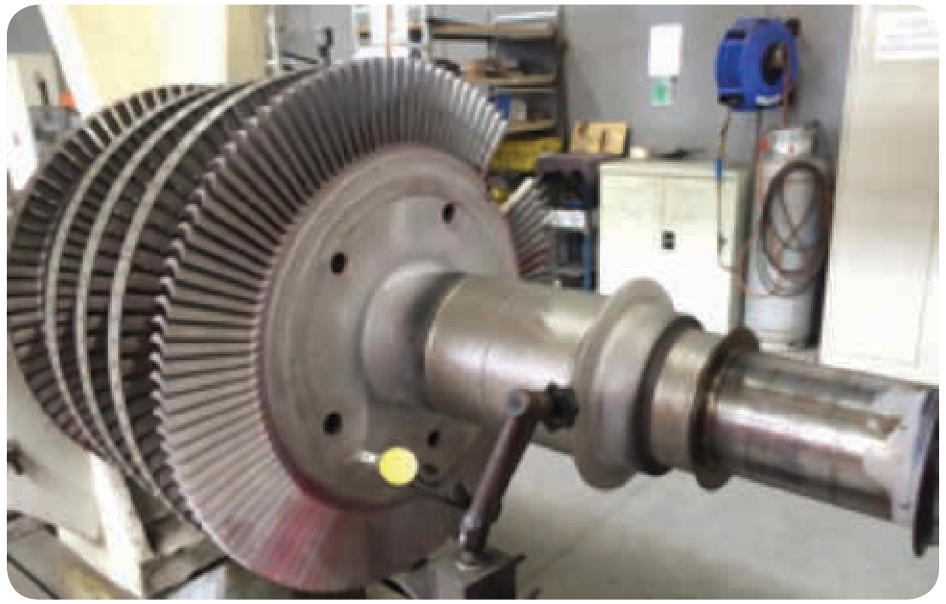
South Africa-based coating specialist, Thermaspray, has recently launched a laser cladding facility capable of refurbishing worn or mis-machined components that traditionally could not be refurbished. In addition, the process offers a wide array of protective overlays to new components in industries such as the automotive, petrochemical, offshore oil and gas, pumps and valves, mining and turbomachinery, to name a few.

Laser cladding falls into the welding-processes family. A filler material is introduced to a heat source and melted with the surface of a component, producing a metallurgically bonded overlay. Along with Plasma Transferred Arc (PTA) welding, laser cladding is one of the few process that uses filler materials in powder form. The technology was first developed in the 1980s and has since seen great advances in light beam quality, power output efficiency and total power output. The technology is commonplace in the European, American and Australian markets as the answer to refurbishment of critical components.

Laser cladding, unlike laser welding, is a weld build-up process that applies a metallic overlay material in powder form to metallic substrates using a defocused laser light as the heat source. The laser beam is defocused onto the component surface, which enables exact control of the melt pool diameter. The filler material is introduced into the melt pool with an inert carrier gas that also acts as the shielding gas for the molten pool, and an overlay is formed.



A schematic diagram of the laser cladding process.

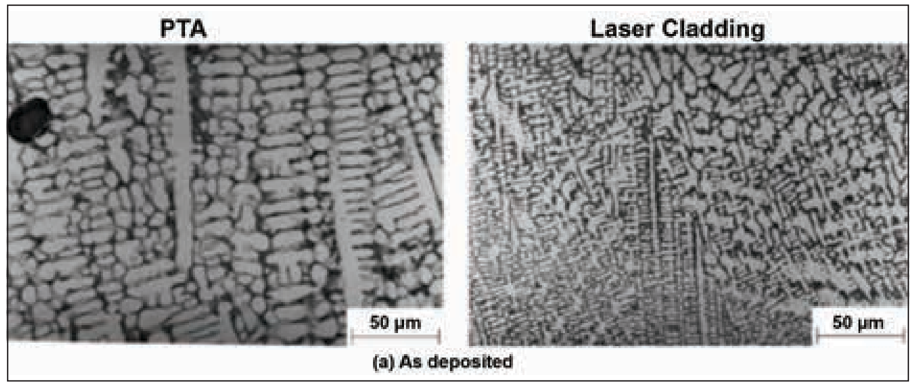


Digitally controlling every aspect of the process from the rate of powder feed, to the path the optics follow and the amount of energy put into the weld pool, allows for accurate and repeatable overlays.

Laser cladding is the ideal solution to protect critical surfaces of new components or to dimensionally restore worn component surfaces to OEM specifications, because the non-porous overlays are metallurgically bonded to the substrate and can be applied to localised areas with precision. These overlays are resistant to mechanical impact and capable of withstanding severely abrasive, corrosive or erosive environments.

Laser cladding differs from traditional welding methods for refurbishment in that it applies a small – between 1.0 and 4,0 mm – bead to the substrate at high traverse speeds – typically at speeds ranging between 500 and 2 000 mm/min. This, in turn, results in overlays that exhibit heat-affected zones thinner than one millimetre and with less than 5% dilution between the overlay and substrate, while still forming a fully metallurgical bond with accurately deposited bead thicknesses – usually ranging between 0.5 and 2.0 mm.

These accurately controlled and homogenous beads ultimately translate into near-net shape build-up when refurbishing components or applying overlays to new components, which significantly reduces the time and effort needed for final machining or grinding.



*Above: **Laser clad overlays (right) exhibit finer grains compared to PTA overlays (left).** Image courtesy of d'Oliveira et al., 2002.*

*Left: **Refurbishment of a rotor's bearing lands can be done without the need to the remove blades.***

The overlays are generally harder than those deposited by traditional means – a Stellite 6 overlay deposited through laser cladding will generally be 5 to 10 HV harder than one applied through Plasma Transferred Arc welding. This is attributed to the fact that the small melt pool produced by the defocused laser cools rapidly, resulting in finer grains and a more homogenous microstructure in the overlay material.

The small molten weld pool and steep temperature gradients also result in the added benefit of significantly less heat input into the substrate material. This allows the application of overlays onto components that are sensitive to distortion through heat input and that traditionally could not be refurbished with welding methods. Suitable applications include shafts, cylinders, housings and rotors.

The small heat-affected zone, rapid cooling rates and homogenous overlay microstructure also add the benefit that post-weld heat treatment can often be avoided altogether, as there is little to no residual stress remaining in the overlays or substrate material. Preheating of components is also far less detrimental to surface metallurgy as surfaces generally only need to be preheated to 80 to 120 °C, depending on the material.

When compared to thermal spray coatings and Plasma Transferred Arc welding for hardfacing, some key differences between the processes must be noted. These are summarised in Table 1.

Like other welding processes, both laser cladding and PTA overlays are metallurgically bonded to the substrate as opposed to mechanically bonded thermal spray coatings. This metallurgical bond makes laser clad and PTA overlays far more resistant to mechanical impact in comparison to thermal spray coatings. Dilution of laser clad overlays is significantly less than those of PTA and other traditional processes, providing the benefit that it is no longer necessary to apply thick overlays, which are in excess of 4.0 to 5.0 mm in the case of traditional welding based processes, to compensate for substrate dilution in the overlay. Simply put, laser clad overlays can be applied to mere 1.0 to 1.5 mm thicknesses while still imparting the full metallurgical and mechanical properties of the overlay material.

There is a vast range of materials that can be applied to virtually any metallic surfaces from applications to prevent solid-particle erosion, metal-to-metal abrasion, corrosion resistance and dimensional rebuild. Materials that are traditionally known to be unweldable can also be clad or refurbished using the laser cladding process.

In overseas markets, laser cladding has been used for many years as a reliable and cost-effective solution for the refurbishment of expensive or distortion-sensitive components, as well as for the protection of critical surfaces of new components.

"Thermaspray is proud to be introducing this technology to industries in Southern Africa. Our four-kilowatt fibre-coupled diode laser is housed in a booth specifically built for purpose; the entire process is digitally controlled, and an eight-axis robotic manipulator ensures process repeatability and stability," says Jan Lourens, Thermaspray's MD.

"Thermaspray offers its customers turnkey solutions that are tailored to their specific needs, on a job-specific basis. We also provide thermal spray, Plasma Transferred Arc welding, and machining, grinding and polishing facilities. As an ISO 9001:2015 and ISO 3834-2 certified company, customers can be assured that their refurbishment and surface engineering needs will be met at the highest standards by a team with extensive experience and know-how, in a facility that can process components from start to finish," he concludes.

	Laser cladding	Thermal spray coating	Plasma Transferred Arc (PTA)
Type of Bond	Metallurgical	Mechanical	Metallurgical
Bond Strength	≤ 800 MPa	≤ 80 MPa	≤ 800 MPa
Porosity	≤ 0.1%	≤ 1 or 5%	≤ 0.1 %
Mechanical Dilution	< 5%	N/A	5 to 18%
Impact Resistance	High	Low to medium	High
Typical Minimum Thickness	0.5 mm	0.15 mm	2.0 mm
Overlay Materials	Metals and alloys (no composites)	Metals, ceramics, ceramic metal composites	Metals and alloys

Table 1: Comparisons between laser cladding, thermal spray and Plasma Transferred Arc coating processes.