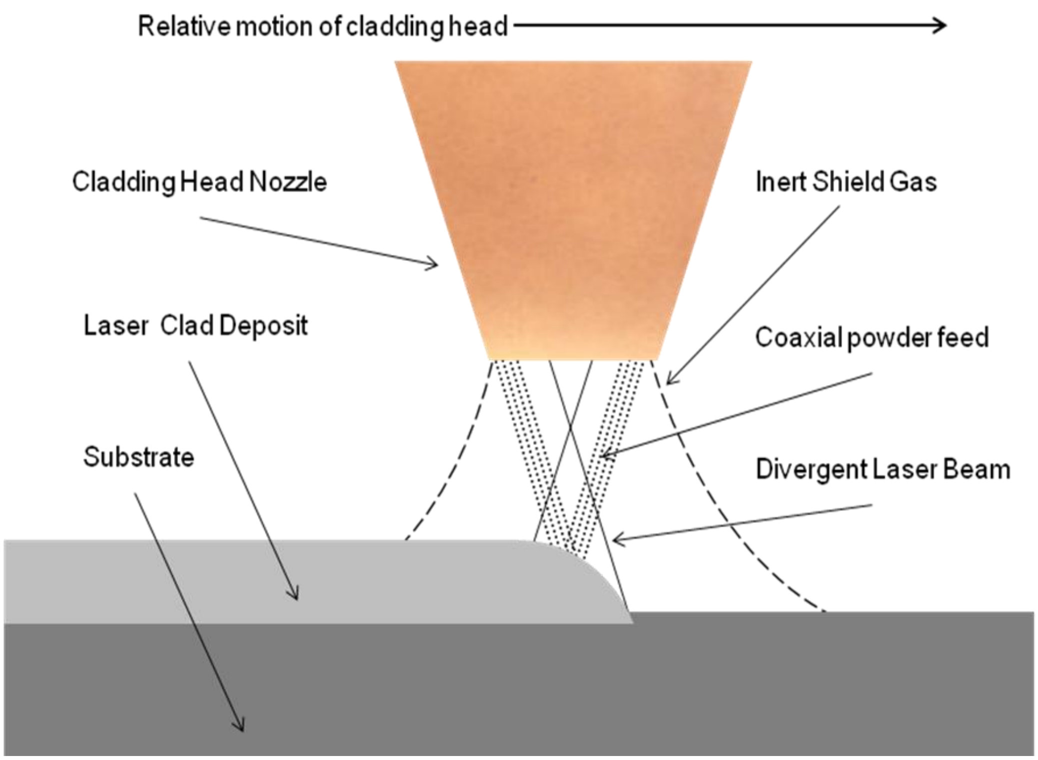
Laser Cladding

Laser Cladding – A Description

- Laser Cladding is a welding process which uses a precisely focused laser beam to generate a melt pool on a component surface. A metallic feed material is simultaneously injected into the melt pool and fully melted to build up a deposit.
- The Feed material usually takes the form of a metallic powder but can also be a wire.
- The precise nature of the process allows the quality of the coating to be accurately controlled.
- The Key to successful laser cladding is controlling the heat input into the base material, which can be minimized whilst maintaining a high strength metallurgical bond.
- The very fast cooling rate associated with laser cladding has the effect of producing fine high strength microstructures with minimal effect on the mechanical properties of the base material.

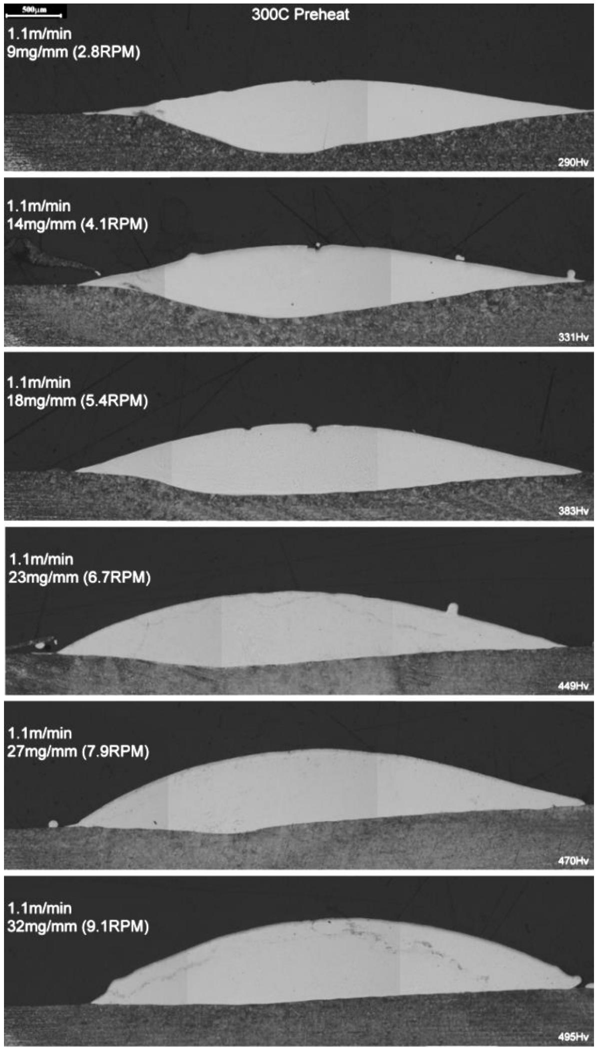
Laser Cladding - Process schematic



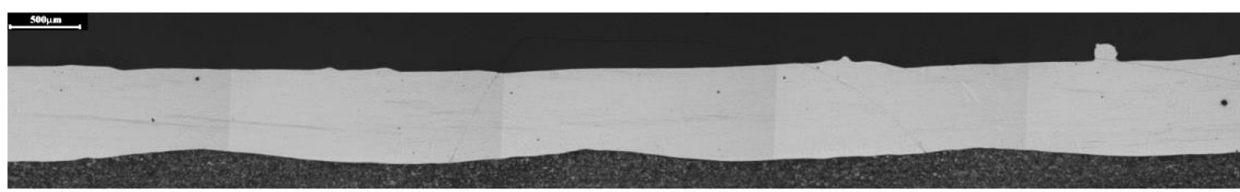
Advantages

- Ability to cost effectively apply thin welded coatings. ~ 0.5 – 5 mm
- Achieve correct chemistry in a single pass due to low dilution
- Huge range of available cladding materials.
- Can clad onto traditionally "unweldable" materials and components due to very small heat affected zones.
- Minimal distortion due to very low heat input
- Very accurate and repeatable
- Excellent surface finish
- Easily automated

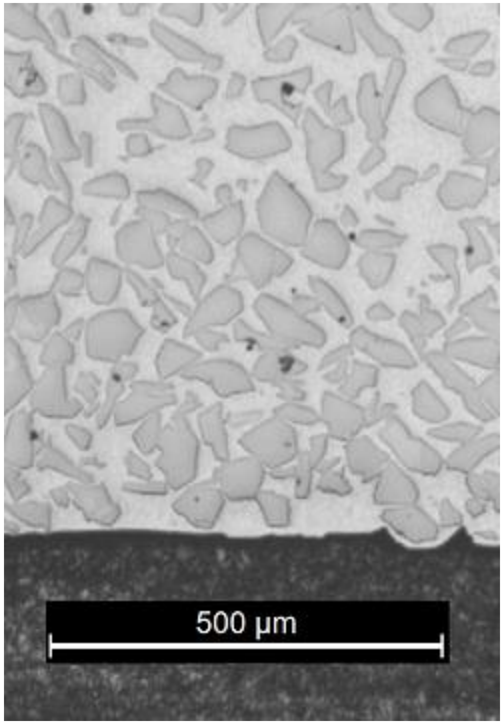
Process Optimisation – Powder feed rate

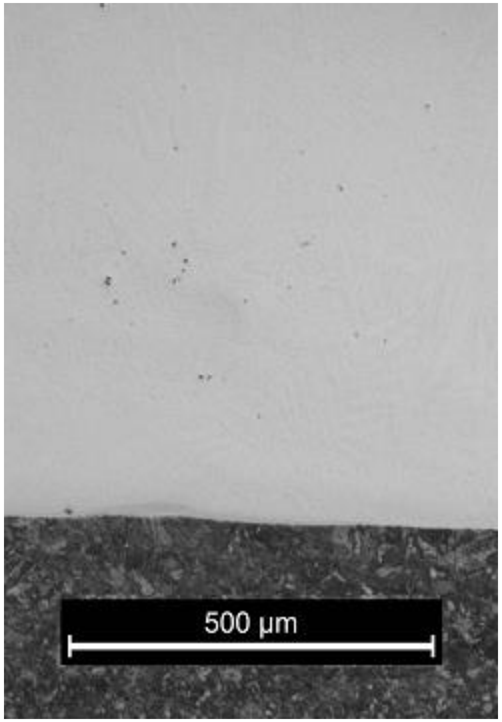


- Laser clad tracks can be accurately produced with various levels of dilution, this can be used to control the deposit hardness.
- By overlapping laser clad tracks, it is possible to coat large components with very accurate, high quality coatings.
- Multiple layers can be applied to achieve the desired coating thickness.
- Hard ceramic particles such as tungsten carbide can be added into the laser clad coating, this provides additional wear resistance.



Laser Cladding – Example Materials

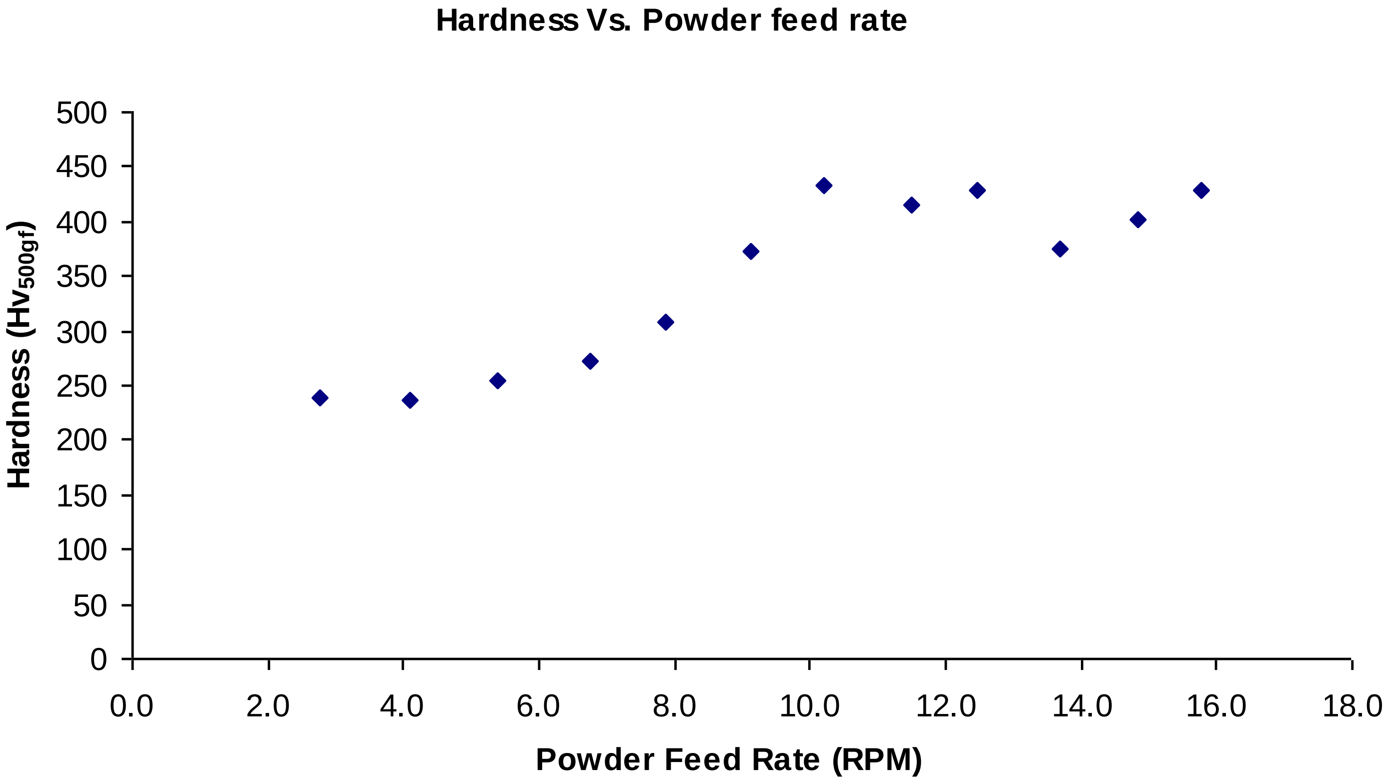




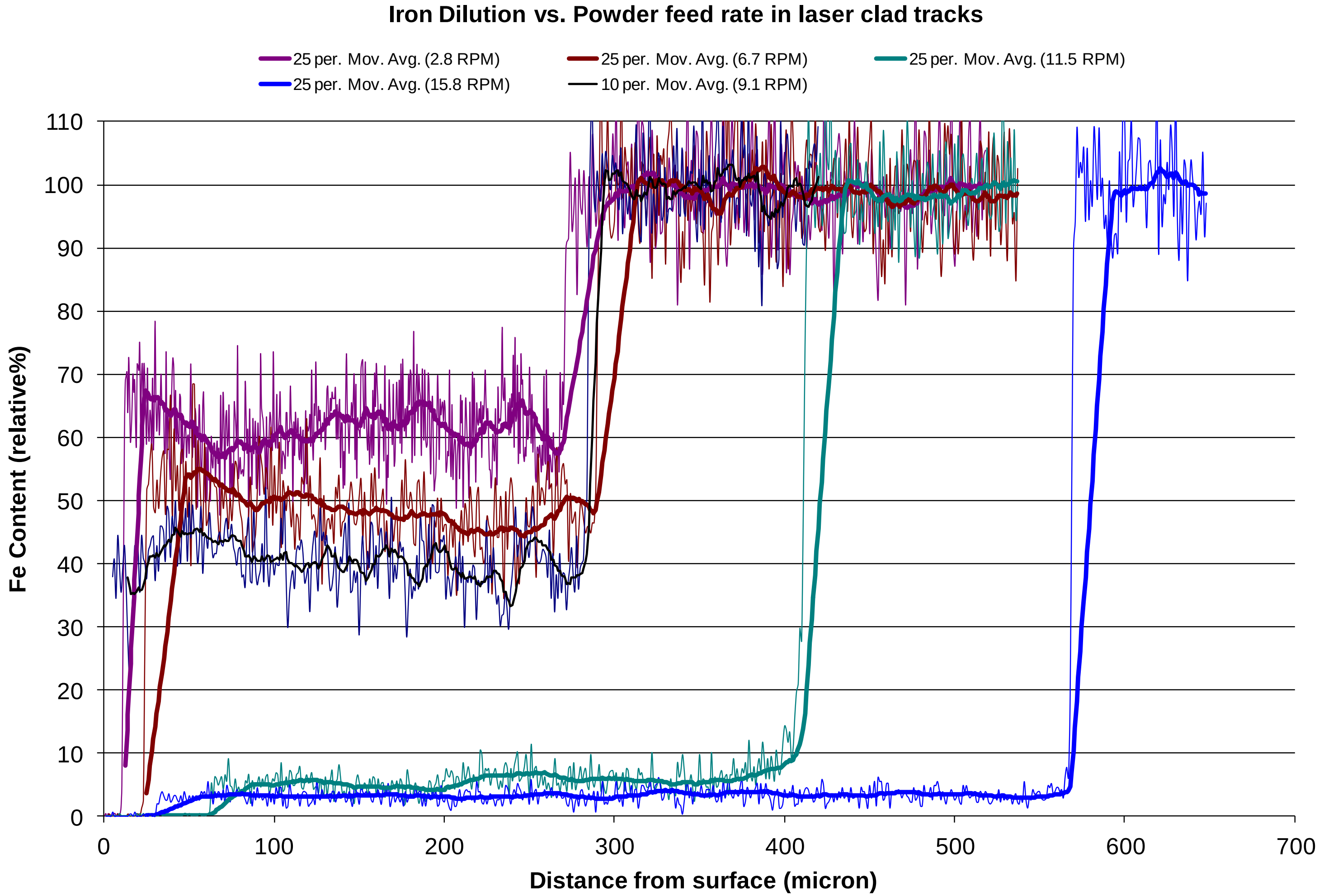
- FeCrSiB 900 – 1100 Hv
- NiCrSiB +60% Tungsten Carbide matrix 550- 650 / hard phase 1500-2000 Hv
- CoCrWc 500 – 600 Hv
- H13 tool steel – FeCrMoV 610 – 700 Hv
- M2 tool steel FeWMoCr – 700 – 900 Hv

Process Optimisation – Powder feed rate vs. Hardness

- This Slide shows how the process can be controlled to produce deposits of different hardnesses with the same feedstock material
- Typically, A Series of trials are conducted to identify the optimum cladding parameters. Including track size, dilution, hardness and porosity for each material.



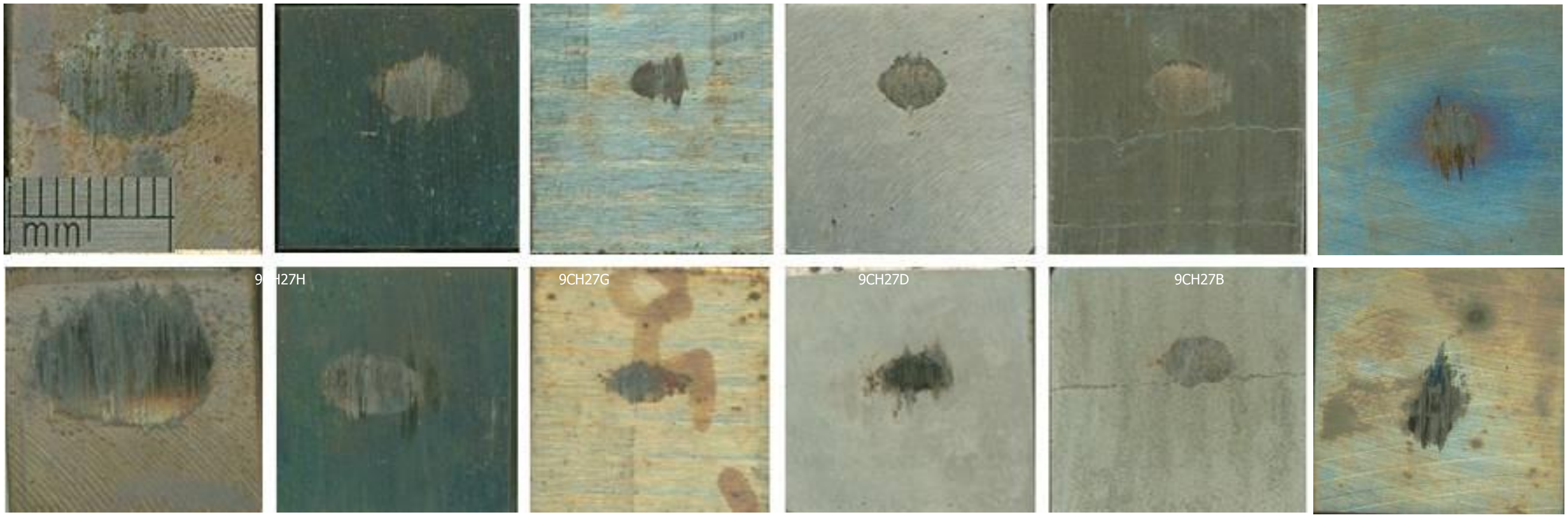
Process Optimisation – Powder Feed Rate vs. Dilution



- This slide shows how the level of base material dilution can be varied and controlled to less than 5 %. This allows the cost effective application of high performance, pure coatings to be applied in a single pass.

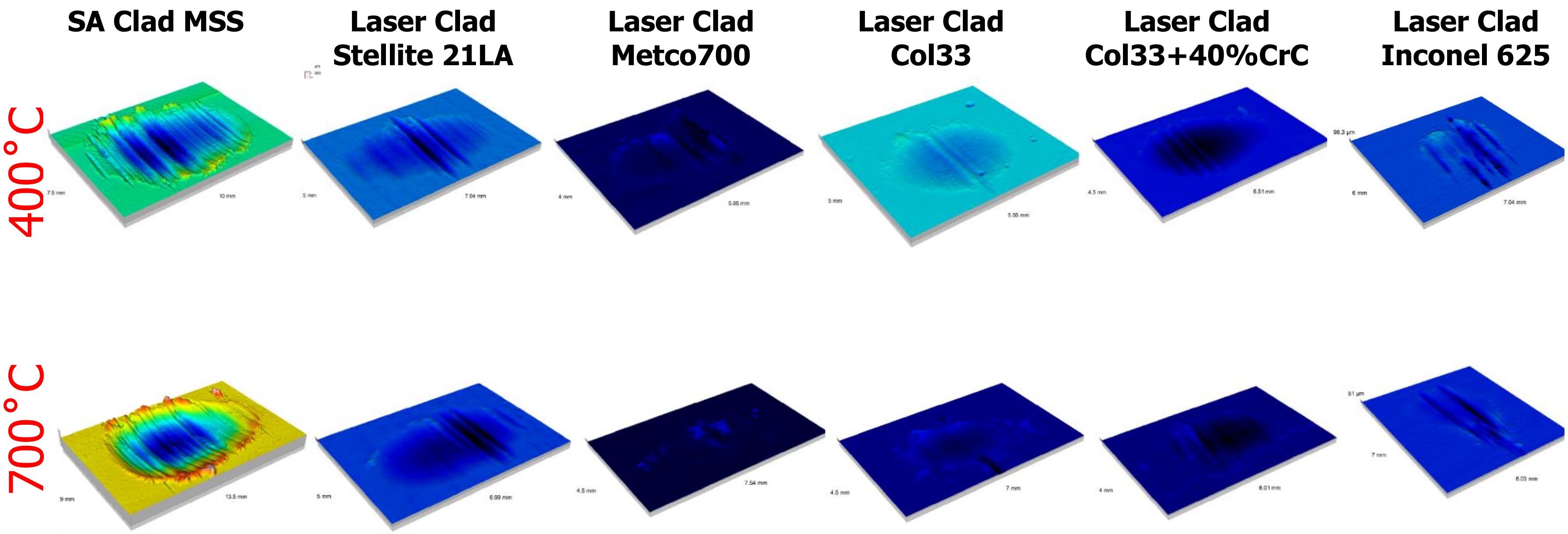
High temperature wear testing – Wear scars

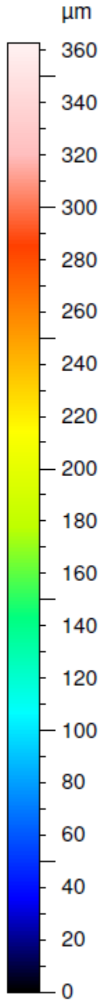
	SA Clad MSS	Laser Clad Stellite 21LA	Laser Clad Metco700	Laser Clad Col33	Laser Clad Col33+40% CrC	Laser Clad Inconel 625
400°C						
700°C						



- These are the six materials which have been tested for their high temperature wear resistance.
- The wear scar volumes and mass losses have been measured, which can be plotted as wear resistance.
- The Effects of the temperature is visible on the surface, with the iron and cobalt based materials being the most heavily oxidised

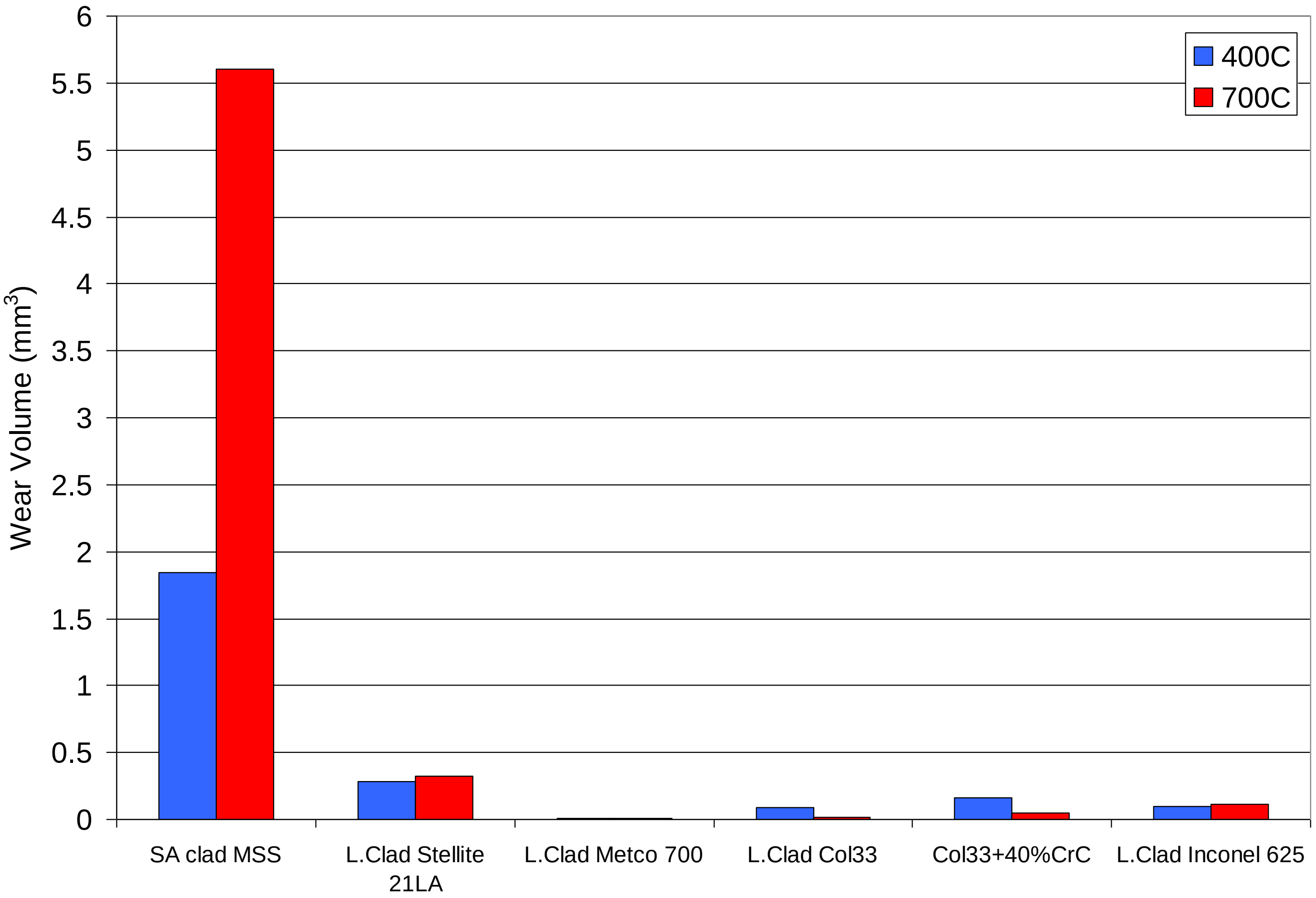
High Temperature Wear – Volume loss measurement





- Talysurf measurements were conducted to find the volume loss of each sample
- This volume loss can be plotted as a measure of wear resistance

Hot Wear Test Results



The increase in high temperature wear resistance of the laser clad alloys compared to conventional welded stainless steel is between 5x and 20x in all cases

This is a result of both the increased hardness of the laser clad alloys due to microstructural refinement,

And the increased hot hardness due to the high level of alloying elements Cr, Mo, W etc

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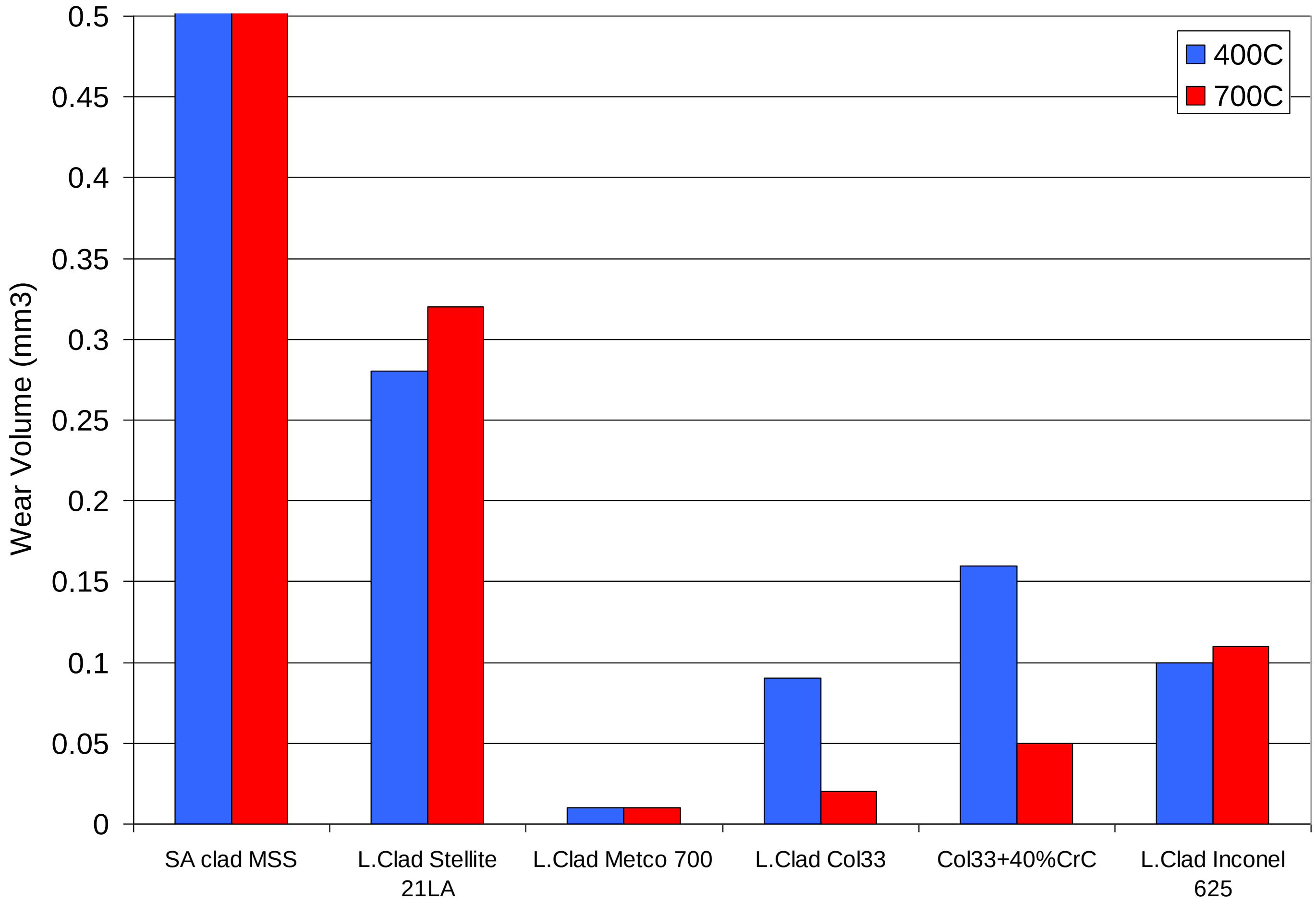

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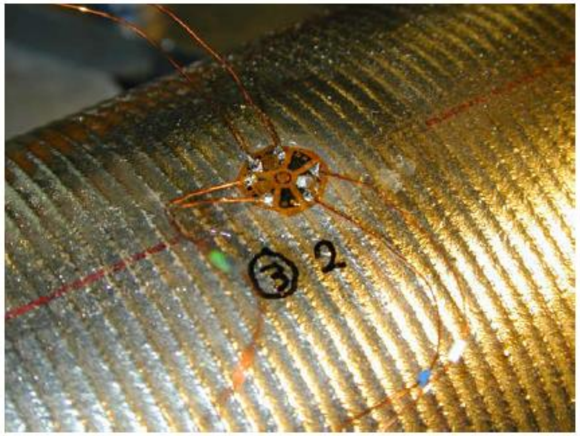
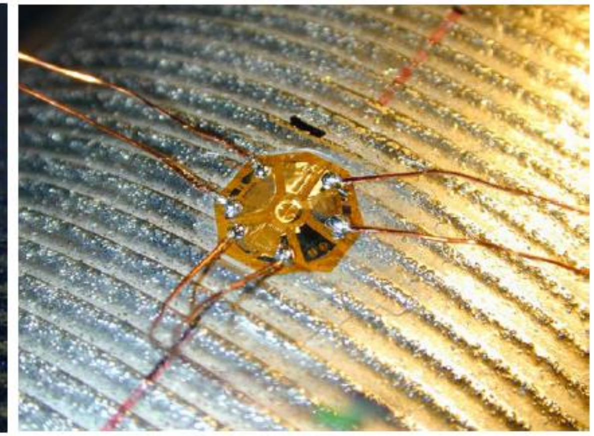
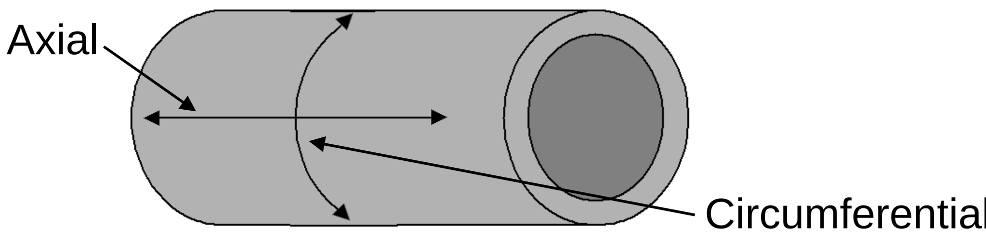
Residual Stress Measurements – Hole Drilling Method

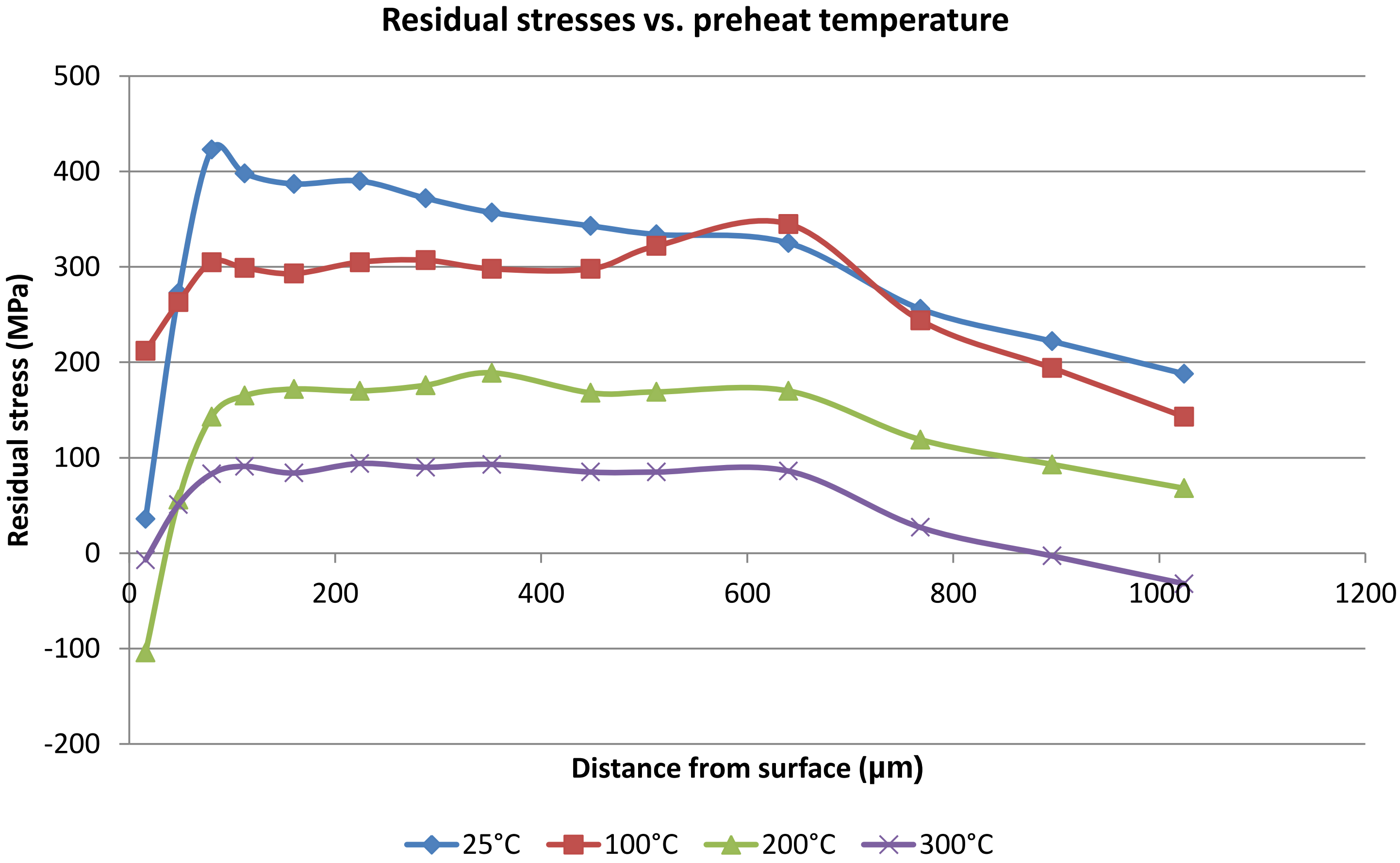






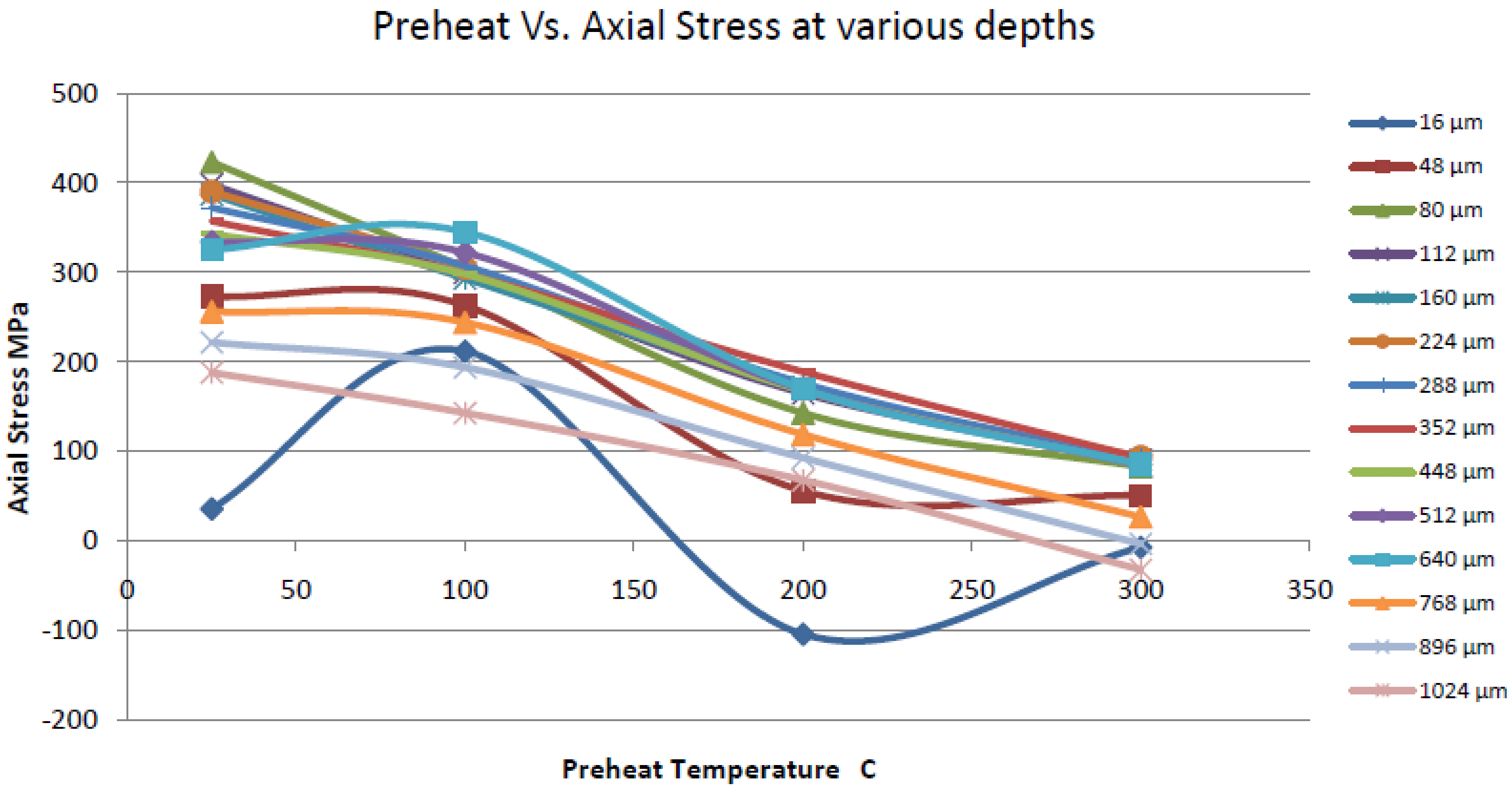
- Strain gauges are glued to the specimen surface, aligned to the Axial (length of tube) and Circumferential (Cladding) directions.
- A small CNC milling machine is used to orbital drill a small hole at the centre of each gauge allowing strain relaxation, which is measured and related back to the residual stresses.
- The amount of relaxation is measured at specific drill depths and a residual stress profile is built up.

Residual Stress measurements – Preheat vs. Residual Stress



- Component preheat has been identified as a very effective method to minimise cracking.
- Increasing the preheat temperature will decrease the residual stress levels.

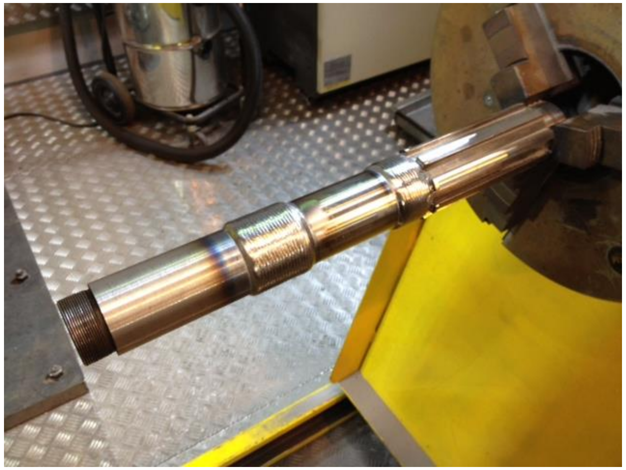
Residual stress measurements – Preheat vs. Residual stress

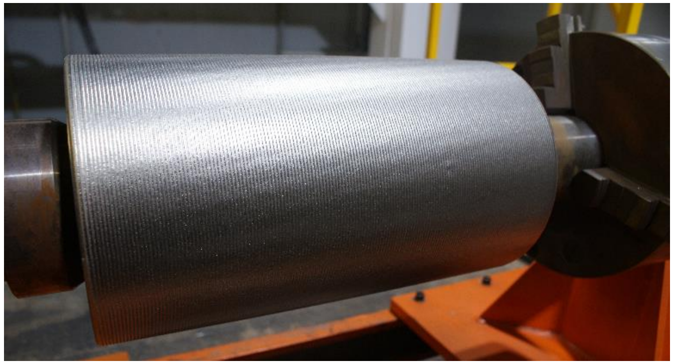


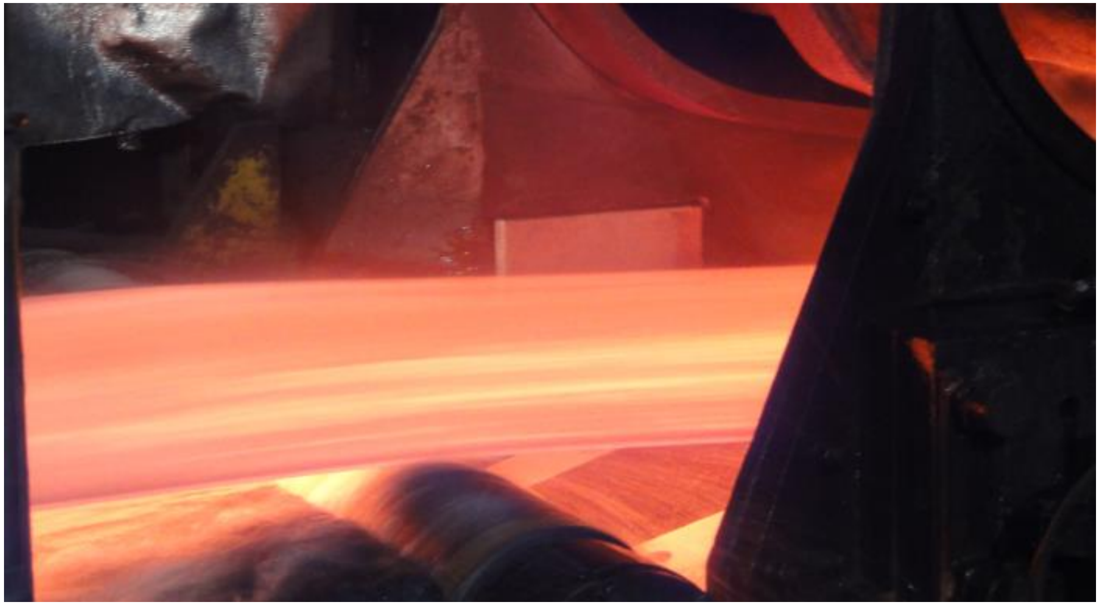
- The same data represented in a different way, shows a strong linear trend between the residual stress and preheat temperature. At any given depth.
- The shallower measurements however show a much larger variability, due to experimental error.

LASE LTD

A selection of laser clad components





LASER APPLIED SURFACE ENGINEERING

Conclusions

- Laser Cladding is a very accurate and controllable process which lend itself well to applications where high quality is required
- Lase cladding can be used to coat new components prior to service in order to extend the service life. And it can be used to repair worn or damaged components back to original dimensions with a fully dense welded coating.
- Careful parameter selection allows very pure coatings to be applied in a single pass. This allows the cost effective cladding of expensive materials.
- The minimal heat input associated with laser processing allows coating and repair of components which would crack or distort with conventional welding techniques.
- The fast cooling rate produces high strength coatings which have superior mechanical properties compared to any other welding process. This yields improvements in wear performance and component lifetimes.
- Ceramic reinforced coatings can be produced which contain a high volume fraction of hard particles which excel under extreme abrasion conditions.