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New repair technique for aero-engine components using Laser Metal Deposition

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Areas of application
- Gas turbine repair and overhaul
- Aero engine repair and overhaul
- Stationary turbines (power generation) repair and overhaul
- Gas turbine production

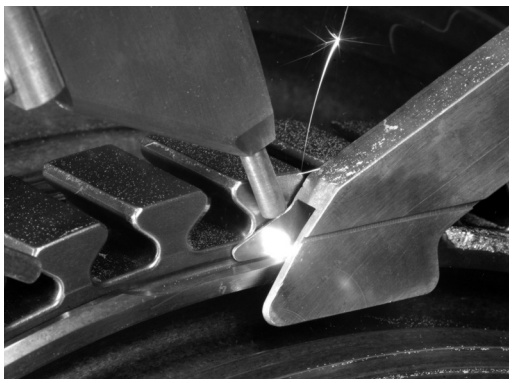
Technological impact
- New repair process for aero-engine components
- Reduced process costs
- Shorter development lead time
- Improved quality assurance

Abstract
With an increasing number of engines being operated under »Flight Hour Agreement« terms, Rolls-Royce has to find ways to minimise the operating costs of hardware. Therefore innovative repairs of key components are vital to achieve that goal. One innovative approach to this is Laser Metal Deposition, which enables the restoration of features that were previously classified as non repairable.

Processes like Direct Metal Deposition (DMD) and adaptive machining are being developed to accommodate such challenges by repairing instead of replacing. With a focus on high value / high volume parts made of Titanium or Nickel material (e.g. Blisks, HPC-Drums, Casings, HPT-Discs), Laser Metal Deposition is gaining more and more importance. This enables successful repair of components returning from service as well as the salvage of parts damaged during new part manufacture, which previously was not feasible.

Laser Metal Deposition (LMD) works usually with a powder, which is fed into the interaction area between the laser and the component. The laser melts a small portion of the base material and the powder leading to a metallurgical bonded layer. The heat input is extremely low due to the fact that the laser can be focused to small areas and does only interact at this particular area means there is no interaction with closely surrounding features. Also the laser power can be adjusted with high precision, thus avoiding distortion of the component and micro structural changes. Key to the process is the development of new powder feeding nozzles as well as the development of repair procedures that are capable of applying a local shielding atmosphere during the repair process, without having to place the components in a process chamber.

The BR700-715 HP Compressor Front Rotor Drum Assembly is, for example, a rotating titanium component. In service wear caused by the damping wire as well as the retaining groove lock plate leads to a component that must be declared unserviceable. The damage is beyond acceptance limits and also beyond limits to allow repair using alternative techniques such as thermal spray or TIG welding. The capability to return a high value rotating titanium component previously thought not to be repairable, within a relatively short development time frame, is an innovative technical improvement for the repair capabilities within Rolls-Royce.



Left: High value components suitable for the repair with Laser Metal Deposition (Photo: Rolls-Royce Deutschland Ltd. & Co. KG).
Right: Laser Metal Deposition process for the repair of the retaining grove lock plate of an HPC front drum (Photo: Fraunhofer-Institut für Lasertechnik ILT, Aachen, Germany).