

# LENS™ Blisk Repair Solution

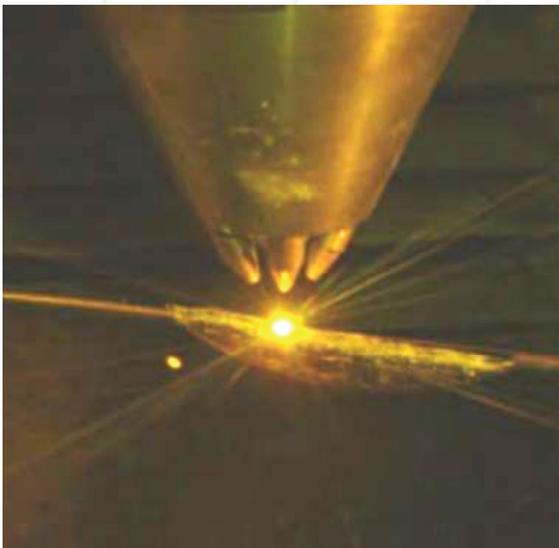
LENS (Laser Engineered Net Shaping) systems enable the repair of blisks and other aircraft engine compressor components. *LENS repair solutions can precisely add material to worn or damaged blisks and airfoils to restore their profile.* The exceptional mechanical properties and low heat input of the LENS process make it the preferred choice for the highest quality repairs.

## The Challenge...

Integrally bladed rotors, also known as Blisks, provide many operational and performance benefits over traditional multi-component designs. However, they can cost tens or even hundreds of thousands of dollars to manufacture and consequently replacing damaged blisks can significantly increase in-service operational costs. The challenge therefore is to develop an effective repair technique that can guarantee that all airfoils can be repaired – for if one airfoil is unrepairable, the entire blisk must be scrapped.

## The Solution:

After years of process development and independent testing by leading aerospace manufacturers, the LENS process has emerged as the preferred solution for material addition for blisk repair. Unique capabilities of the LENS process include:



Ti-6-4 airfoil leading edge repair, in process.

- » **Low Heat Input:** The airfoil does not distort beyond dimensional limits
- » **Small Heat Affected Zone:** Minimizes degradation of the mechanical properties of the airfoil
- » **Superior Mechanical Properties:** LENS Ti-6-4 fatigue properties equivalent to wrought material
- » **Excellent quality:** Full environmental control ensures extremely low micro-porosity levels
- » **Complex Shapes:** Virtually any cut-out can be filled
- » **Greater Repair Access:** Even non-line-of-sight areas can be repaired
- » **Near-Net-Shape:** Minimizing finishing time

# Blisk Repair Case Studies

## Quality at an Affordable Price

Only LENS systems offer full environmental protection of the part at all times during the repair, thanks to the controlled environment enclosure. But this quality doesn't mean that economics are sacrificed. From our closed-loop controls, to the near-net-shape repair, we help to ensure that throughput is high, so that the LENS system provides a quality repair at an affordable price.



## Blisk Repair with LENS 850-R

The LENS 850-R system utilizes a Fiber Laser together with powdered metal to make a fully-dense metal build-up repair with exceptional quality and properties. The repair toolpath is generated by the on-board vision system, or even from a prior 3D scan of the part. The repair is made layer by layer under the control of software that monitors a variety of parameters to ensure geometric and mechanical integrity. The LENS process is housed in a chamber which is purged with argon such that the oxygen level stays below 10 parts per million to ensure there is no impurity pick-up during deposition. The metal powder is fed to the process by Optomec's proprietary powder-feed system, which is able to flow small quantities of powder very precisely. When complete, the part is removed and can be heat-treated, machined, and put back in service.

## Case Study:

### T700 Blisk Repair Demonstration

The T700 blisk, made from AM355 steel, can suffer from erosion on the airfoil leading edges during service. Optomec developed a leading edge repair using Stellite® 21, a cobalt-based wear-resistant material. The blisk passed Army-mandated spin testing, both a 60,000rpm proof test, and a 50,000-cycle low-cycle-fatigue spin test. Erosion, tensile and metallurgical evaluations all confirm the quality of the repair. Economic analysis shows that the LENS process gives an attractive Return on Investment without sacrificing quality.



T700 Stage 1 blisk after LENS leading edge repair

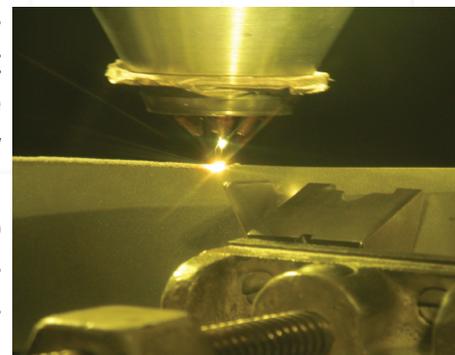


Blisk after finishing

## Case Study:

### Ti-6-4 Blisk Repair Demonstration

Optomec has demonstrated repair of Ti-6-4 blisk airfoils with a leading aircraft engine manufacturer. A comprehensive mechanical testing program completed by the manufacturer in 2006 showed material properties of LENS Ti-6-4 repairs equal to or better than the base material. The repair has been downselected against competing repairs, and has passed several major development milestones. Independent fatigue testing by EADS, and others, has shown LENS mechanical properties to be equivalent to wrought material. See [www.optomec.com/site/lens\\_2](http://www.optomec.com/site/lens_2) for details.



Ti-6-4 airfoil leading edge repair, in process.

# OPTOMEC®

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## THE OPTOMEK LENS DIFFERENCE

Fielding a new repair, let alone a blisk repair, is no trivial task. Optomec has the staff and equipment to work with you to achieve your goals. Our applications development team has 40+ years of combined experience in laser materials processing. Optomec invests over \$1M per year in process and equipment development, and is committed to remaining at the leading edge of advanced metal component repair.

# [www.optomec.com](http://www.optomec.com)