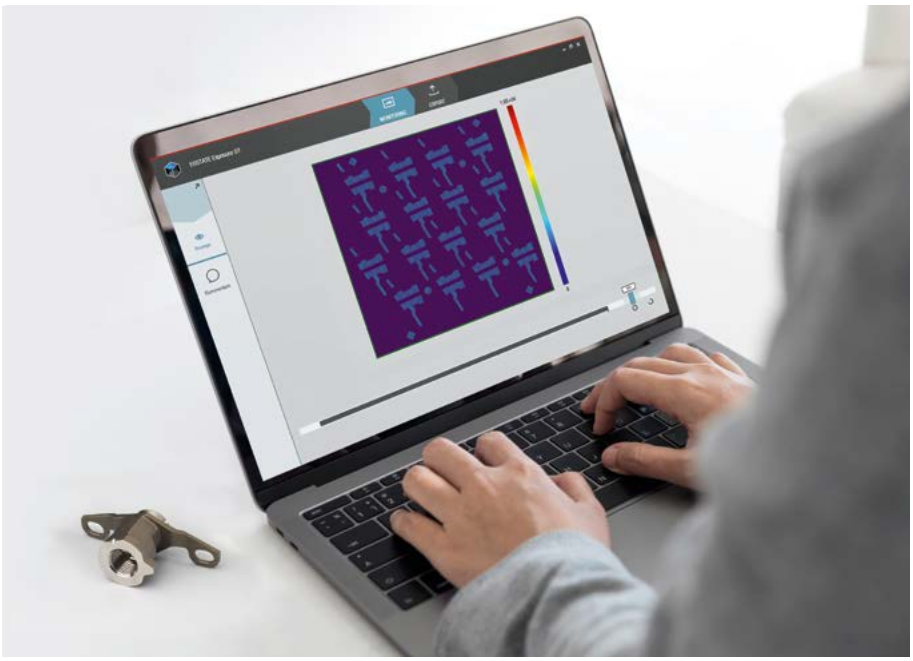
Success Story
Aerospace

Optical Tomography Enables Considerable Savings in Quality Assurance

Source: MTU Aero Engines



When testing additively manufactured components, MTU Aero Engines relies on layer-by-layer live monitoring of the manufacturing process using EOSTATE ExposureOT.

Challenge

Development of optimal quality assurance for additively manufactured components

Solution

Application of EOSTATE ExposureOT to the series production of turbine parts

Results

Higher probability of detection than conventional non-destructive methods (X-ray and CT scan)

Establishment of EOSTATE ExposureOT as an official testing procedure for additively manufactured components

End-To-End Monitoring
During Series Production

Components produced for the aerospace industry must satisfy strict quality assurance criteria. Especially in series production environments, there are high standards for component quality and hence process stability and reproducibility. End-to-end quality assurance is therefore crucial throughout the entire production chain.

Just a few years ago, there were no well-established testing procedures for additive manufacturing, which is why non-destructive and downstream processes such as dye penetrant testing, X-rays, and computer tomography (CT) were used for metal components. Although these conventional testing methods are an effective way to certify components in some cases, they are highly expensive and often insufficient. Quality assurance can cost many times more than production.

Challenge

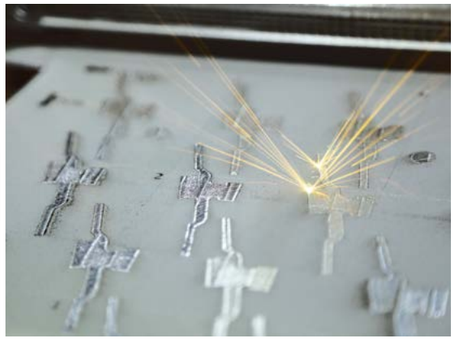
New additive manufacturing processes face major challenges in the engine construction sector due to the extremely stringent requirements of safety certifications. Any component destined to fly must be continuously monitored, from raw material to final product, in order to ensure that it is completely free from faults. This means that quality assurance for industrial 3D printing – testing technology, process control, and documentation – needs new methods and economic ideas.
MTU Aero Engines began to develop optical tomography (OT) in 2013 with the objective of finding a specific testing procedure that could provide 100 % monitoring and documentation for additive manufacturing processes. After successful initial research and implementation phases, this technology was further developed into the series solution EOSTATE ExposureOT in partnership with EOS GmbH.

Short Profile

MTU Aero Engines is Germany's leading engine manufacturer and a well-established player worldwide. The company develops, manufactures, sells, and maintains both civil and military aircraft engines in every thrust and power class, as well as stationary industrial gas turbines. MTU has subsidiaries and affiliates worldwide in key regions and markets. One of the breakthroughs achieved by MTU was in the engine construction sector as one of the first ever companies to manufacture serial components by DMLS (Direct Metal Laser Sintering).

Further information
www.mtu.de

Additive serial manufacturing of borescope bosses for geared turbofan engines of Airbus A320neo. (Source: MTU Aero Engines)



The system monitors the entire manufacturing environment with an sCMOS industrial camera and measures the heat emissions of the melting process in high resolution. The configurable software offers detailed insights into the quality of the components in each layer. Optical tomography therefore allows reproducibility to be monitored, increases comparability between components, manufacturing projects, and printing systems, and provides a way of integrating cost-effective quality assurance into series manufacturing applications. MTU Aero Engines now aims to establish EOSTATE ExposureOT as a testing procedure for additively manufactured components and thereby significantly reduce the costs associated with quality assurance.

Solution

MTU Aero Engines has been using EOSTATE ExposureOT for several years in additive serial manufacturing, namely for the process development and quality assurance of borescope bosses for the latest generation of Airbus A320neo geared turbofan engines. This has allowed the company to acquire comprehensive experience of this quality assurance process and perform comparisons with alternative non-destructive technologies. Initially, serial components were inspected with conventional radiographic tests and CT scans in parallel to optical tomography, and the results were systematically compared. The decisive question: can EOSTATE ExposureOT detect every possible type of defect, including cavities, pores, solid inclusions, or incomplete fusion, just as reliably as the conventional test methods? Could EOSTATE ExposureOT even achieve a greater probability of detection (POD)? Comparisons with destructive test methods such as microscope inspections of cross-sections and samples were also systematically performed. The reliability revealed by the findings gradually built up confidence in the new technology and led to a paradigm shift in quality assurance at MTU. Layer-by-layer live monitoring of the manufacturing process with EOSTATE ExposureOT is now the procedure of choice for testing additively manufactured components.

Results

A decisive milestone for series production at MTU Aero Engines with EOSTATE ExposureOT was reached when it was established that this technology reliably detects all potential defects. Comparisons of EOSTATE ExposureOT and conventional radiographic tests, CT, and destructive testing methods found that the POD of EOSTATE ExposureOT was higher than the other non-destructive methods, especially for incomplete fusion. Concretely, this means that any error detected by RT or CT scans is also clearly visible as an indication in EOSTATE ExposureOT. "EOSTATE ExposureOT reliably tells us when a part might have flaws. It hasn't missed a single one yet. This allowed us to completely remove X-ray and CT inspections in the series production of borescope bosses. Economically speaking, the benefit is huge," says Dr. Karl-Heinz Dusel, Head of Additive Manufacturing Technology. In the future, Germany's leading engine manufacturer plans to upgrade EOSTATE ExposureOT from a simple process monitoring technique to an official test method. Statistical process control can also greatly simplify the evaluation of results. With just a few qualitatively defect-free manufacturing jobs, a reliable curve of tolerable deviations can be defined, and any parallel sampling process can be replaced. Further tests are only needed when deviations are observed.

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Dr. Karl-Heinz Dusel,
Head of Additive Manufacturing Technology, MTU Aero Engines

NOTE: approval is still pending for the EOS M 290, which will not be used for series production until 2019

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