Titanium aluminide - MTU Aero Engines develops new turbine blade material

* Ceramic-metal materials – lightweight, creep- and heat-resistant
* **First application in the geared turbofan powering the Airbus A320neo**

Munich, March 23, 2015 – MTU Aero Engines’ materials experts and their partners have jointly developed a new class of unique, intermetallic high-temperature materials for highly stressed engine components: Titanium aluminide (TiAl) is the name of the new lightweight material for turbine blades that combines the advantages of metallic and ceramic materials, offering the best of both worlds. The job was done in record time. “While previously, the introduction of a new material used to take 20 years or so, we’ve succeeded in coming up with an entirely new material class and maturing it for production within a mere seven years,” comments MTU Chief Operating Officer Dr. Rainer Martens.

The hardware is already flightworthy: Back in late September of last year, an Airbus A320neo was the first aircraft ever to take to the skies with custom-made TiAl blades installed in its engines; certification was then obtained last December. The blades in the new material are fitted to the third rotor stage of the unique, three-stage, high-speed low-pressure turbine developed by MTU for the geared turbofan engine for the A320neo. Research continues unabated: The materials experts are busy developing an enhanced TiAl alloy. Their aim is to make more turbine stages from the new material. The innovation would be good news for the environment – for TiAl allows engines to be built that use up less resources, burn less fuel, and are cleaner and quieter than today’s models. “I’m sure that his material will help further bring down the weight of engines appreciably,” adds Martens.

**Compelling properties**

Specialists have been thinking of ways to tap the immense potential afforded by TiAl-based intermetallic materials for aero engine applications for many years. The material properties are amazing: TiAl is an alloy that exhibits a unique combination of ceramic and metallic characteristics. In terms of mechanical properties, it is almost equivalent to the nickel alloys in use today, although its density is much lower; it has a high melting point and a considerably higher creep strength than titanium alloys. These properties are attributable to the specific composition of the alloy and to the multiple heat treatments especially developed for the purpose.

Turbine blades in TiAl are only about half the weight of comparable nickel-alloy components but boast the same reliability and durability. On top of that, the high aluminum content makes the material resistant to oxidation and corrosion. This is why TiAl is the ideal candidate for applications under extreme conditions – high temperatures and pressures –, such as those prevailing in a high-speed low-pressure turbine. “We’ve been mulling the use of titanium aluminides ever since we started work on this unique low-pressure turbine for the geared turbofan,” recalls Dr. Wilfried Smarsly, representative, advanced materials at MTU.

Titanium aluminides open up new horizons for design engineers, for they help reduce the weight of other engine components too: The high centrifugal forces acting on turbine disks and shafts required these components made from heavy nickel alloys to be massive. Thanks to the use of TiAl blades, these centrifugal forces are now much lower. As a result, the disk design can be optimized for appreciably lighter weight. And each reduction in weight will improve fuel economy and CO2 emissions.

The biggest hurdle that stood in the way of the use of the lightweight material in the game-changing geared turbofan was its poor ductility: TiAl is extremely difficult to form. Previously, it turned out impossible to forge turbine blades using conventional, affordable methods. “We performed thermodynamic calculations to determine the optimum temperature range and phase configuration for forging,” explains Prof. Dr. Helmut Clemens, who heads up the Department of Physical Metallurgy and Materials Testing at Montanuniversität Leoben in Austria. Last year, Clemens, one of MTU’s development partners, was honored in Japan with the Honda Award for his groundbreaking research work. Says Clemens: “With the TiAl alloy now developed, forging can be carried out on conventional forming machines – that’s what makes things so radically different.”

**About MTU Aero Engines**

MTU Aero Engines AG is Germany's leading engine manufacturer. The company is a technological leader in low-pressure turbines, high-pressure compressors, turbine center frames as well as manufacturing processes and repair techniques. In the commercial OEM business, the company plays a key role in the development, manufacturing and marketing of high-tech components together with international partners. In the commercial maintenance sector the company ranks among the top 5 service providers for commercial aircraft engines and industrial gas turbines. The activities are combined under the roof of MTU Maintenance. In the military arena, MTU Aero Engines is Germany's industrial lead company for practically all engines operated by the country's military. MTU operates a network of locations around the globe; Munich is home to its corporate headquarters. In fiscal 2014, the company had a workforce of some 9,000 employees and posted consolidated sales of approximately 3.9 billion euros.

Your contacts:

Melanie Wolf Martina Vollmuth

Senior Manager Press and PR Press Officer Technology

Phone: +49 (0)89 14 89-26 98 Phone: +49 (0)89 14 89-53 33

Mobile: +49 (0) 170-799 6377 Mobile: +49 (0) 176-1001 7133

Email: Melanie.Wolf@mtu.de Email: Martina.Vollmuth@mtu.de

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