NASA TECH BRIEF

Lewis Research Center

Ceramic Thermal Protective Coating Withstands Hostile Environment of Rotating Turbine Blades

A simple, two-layer, highly adherent, ceramic coating of an NiCrAlY bond coat and a yttria- (Y_2O_3) or magnesia- (MgO) stabilized zirconia thermal barrier overlayer has been developed to resist the thermal, erosive and corrosive environment and centrifugal stresses encountered by gas turbine engine blades.

The ceramic coatings have a low thermal conductivity and therefore impose a thermal barrier between high temperature combustion gases and air-cooled metal parts such as combustor and turbine blades and vanes in aircraft engines, power generating turbines, or other cooled component applications. These low thermal conductivity ceramic coatings insulate the working parts thereby providing reduced metal temperatures, increased cycle temperatures or decreased coolant requirements. These features provide a potential for increased engine performance, reduced fuel consumption, use of less costly materials or construction procedures and increased life and durability.

This new NiCrAlY/zirconia coating on an air-cooled blade completed a severe test consisting of 500 one-minute cycles in a J-75 gas turbine engine at coating surface temperatures of 1338 K(1950°F) with no adverse effects. In tests conducted in an engine combustion gas simulation facility, the coating withstood 3200 1.2-minute cycles at 1561 K (2350°F) and 1950 cycles at 1644 K (2500°F) with only very low cooling air flow needed to maintain the substrate metal temperatures between 1172 and 1244 K (1650 and 1780°F). Test times greater than 200 hours with temperature drops across the ceramic coating as high as 755 K (900°F) have also been achieved.

The NiCrAlY bond coating is plasma sprayed onto the turbine blade to a thickness from 0.0076 cm (0.003 in) to 0.0177 cm (0.007 in) in an air environment, therefore, no special cover gas or inert atmosphere chamber is needed. The adherence capability is five times that of previous Ni-20Cr alloy bonds. Similarly, the NiCrAlY bond coat has superior adherence to the plasma sprayed zirconia barrier coating. The zirconia coating can be polished to reduce aerodynamic frictional losses as well as to further improve resistance to cracking under operating stresses.

Note:

Requests for further information should be directed to:

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Patent Status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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