Coating Nano-Architecture Leads to Improved Engine Performance

Engineered nanostructures applied to compressor airfoil surfaces can significantly reduce material loss in aviation turbines during service, leading to improved engine performance and resulting in huge reductions in fuel costs for the aviation industry. Dust particles ingested by these engines during takeoff results in severe degradation of the airfoils in conventional turbines, resulting in a marked decrease in engine efficiency after just months in service. To address this issue, researchers at MDS-PRAD Technologies, Inc., in collaboration with scientists at the National Energy Technology Laboratory and engineers at Delta Airlines, have designed a wear-resistant coating with a unique nano-structured architecture that is proving to significantly reduce erosion of compressor airfoils in aeroturbines, and which may lead to a significant increase in fuel efficiency in these engines. The nanostructured coating, composed of a multilayered ceramic-metallic weave, provides enhanced erosion resistance to the airfoil leading edges, resulting in a significant improvement in edge retention. Laboratory tests to date indicate that the nanocoating will provide a compressor efficiency retention on the order of 0.5–1.5% per year, providing Delta Airlines with a projected $100,000,000/year in fuel savings. Once FAA-mandated performance testing is completed later in 2009, Delta Airlines expects to prove the nanocoatings on its fleet of GE CFM56-7, CF6-80A, and CF6-80C2 gas turbine engines. Applied to similar engines across the U.S. aviation industry, implementation of these coatings could translate to an annual energy savings of 35 to 70 trillion Btu (6 to 12 million barrels of oil) with a corresponding reduction in CO_2 emissions.

Beyond the aviation industry, the NETL, MDS-PRAD, and Calpine are also exploring the application of these nanocoatings to the compressor blades of land-base turbines, with the goal of enabling inlet fogging as a routine means of power augmentation. In inlet fogging, the evaporation of water droplets increases air density and mass flow, resulting in a 8% increase in power output without an increase in fuel consumption; however, the water droplets are very erosive to the turbine compressor components.

Patents, or other steps to commercialization: MDS-PRAD Technologies, Inc., holds the patents on the nanocoating architecture and application processes. The NETL, Delta Airlines, and Calpine are collaborating with MDS-PRAD Technologies to develop field validation of this concept in route to commercial implementation.

Contributing Agency: DOE