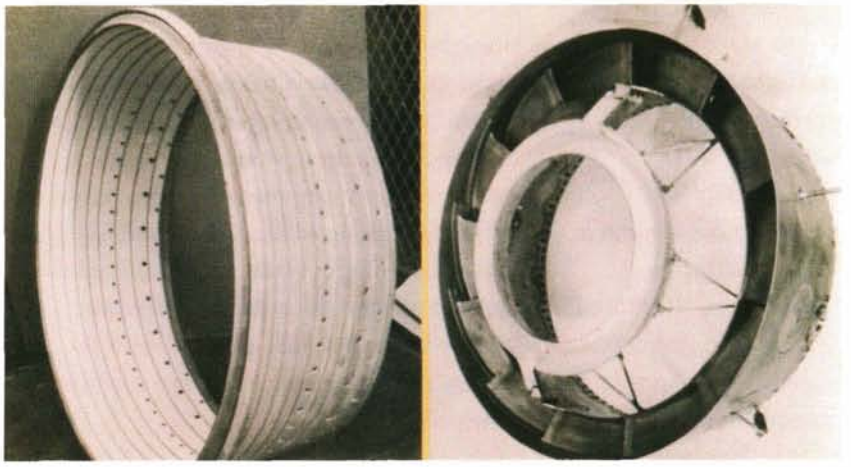
Engine Coatings

For more than 30 years, aircraft propulsion researchers have been investigating ways to increase the operating temperature of turbine engines, which can provide enormous benefits in reduced fuel consumption and overall engine efficiency. To do so, it is necessary to find ways of protecting engine components from the extremely hot environment.



Researchers have explored — and continue to explore — advanced, temperature resistant materials and a variety of concepts for cooling interior engine parts. Lewis Research Center came up with a promising approach: to protect hot components by use of thermal barrier coatings, or TBCs, plasma-sprayed substances deposited on the components in thicknesses measured in thousandths of an inch.

A TBC consists of an outer layer, or "top coat" of ceramic material, plus a metallic "bond coat" inner layer. The low-conductivity ceramic coating insulates the component from the hot gases of the engine; the bond coat offers oxidation and corrosion resistance to the component and increases the adherence of the top coat. Research testing has shown that TBCs can reduce component surface temperatures by 200 degrees Centigrade or more.

Lewis Research Center, together with industry firms working under Lewis contract and on their own, have successfully developed TBCs that have been routinely operating on certain parts of aircraft engines for some time and ongoing research is paving the way for extending the coating process to "hotter" engine components.

An example of industry use of the NASA-developed TBC concept is the application of the coating to engines produced by General Electric Aircraft Engines (GEAE), Cincinnati, Ohio. GEAE was one of three contractors that evaluated TBC performance under contract to Lewis (the others were Pratt & Whitney Division of United Technologies and Garrett AiResearch). GEAE applied this experience to a TBC now in regular service as a coating on production engines.

The company's primary TBC application is a coating on combustor liners in both commercial and military aircraft engines, along with coatings on exhaust liners, flaps, seals and afterburners in military engines (**in the photo**, the component at left is a combustor liner for the CF6 engine that powers commercial jetliners and the other component is a flameholder for the F404 engine that powers military fighter aircraft).

The coating system used for combustors and exhaust components, based on the one developed by Lewis Research Center, consists of a plasma-sprayed nickel/chromium/aluminum/yttrium bond coat and an yttrium-stabilized zirconia top coat. These coatings extend component life from 1.3 to two times by reducing the temperature of the metal in the component. GEAE is also testing TBCs on components that operate at higher temperatures, such as stator vanes and turbine blades, and plans to expand production applications of TBCs. •