Substrate-Coating Interactions and Their Effects on Hot Corrosion Resistance

David Shifler
Naval Surface Warfare Center,
Carderock Division, Code 613, 9500 MacArthur
Boulevard, West Bethesda, MD 20817-5700

Type I and II hot corrosion attack has been observed on certain marine gas turbine engines in the area of the first stage turbine hardware. In order to improve the service life and resistance to Type II hot corrosion of these turbine blades, laboratory testing of the current, baseline coating and several candidate replacement coatings was initiated using a low-velocity, atmospheric-pressure burner-rig (LVBR).

During a recent high-temperature work, it was discovered that high-temperature coating on various superalloy substrates behaved differently during 1000 hours of exposure in a hot corrosion environment at 1650 °F (899 °C). Differences in chemical compositions between a coating and a substrate alloy can lead to interdiffusion between these materials that can modify the oxidation and corrosion resistance of the coating and the mechanical properties of the coating-substrate system. The stress state may also significantly influence and increase the magnitude of the interdiffusion that may lead to deleterious precipitation reactions. The crystal orientation or alloy phase of the substrate may also contribute to interdiffusion rates.

This paper will examine the chemistries of two high-temperature coatings applied on two different superalloy substrates prior to LVBR testing and their respective interactive effects on hot corrosion resistance after exposure to a hot corrosion environment. These interactions will include resultant changes in the chemistries of the coatings and the alloy substrates and possible phase transformations.

Keywords: hot corrosion, aluminide coatings, diffusion coatings, overlay coatings, Alloy 247, Alloy 509, sulfidation, MCrAlY coatings, marine gas turbine