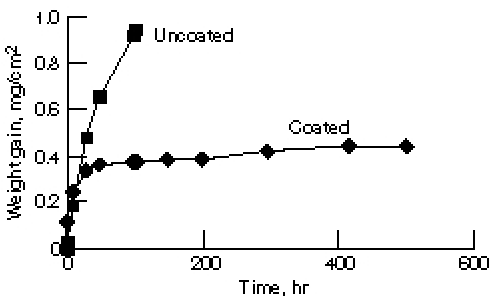
An Oxidation-Resistant Coating Alloy for Gamma Titanium Aluminides

Titanium aluminides based on the γ–phase (TiAl) offer the potential for component weight savings of up to 50 percent over conventional superalloys in 600 to 850 °C aerospace applications (ref. 1). Extensive development efforts over the past 10 years have led to the identification of "engineering" γ–alloys, which offer a balance of room-temperature mechanical properties and high-temperature strength retention (ref. 1). The γ class of titanium aluminides also offers oxidation and interstitial (oxygen and nitrogen) embrittlement resistance superior to that of the α_2 (Ti_3Al) and orthorhombic (Ti_2AlNb) classes of titanium aluminides. However, environmental durability is still a concern, especially at temperatures above 750 to 800 °C. Recent work at the NASA Lewis Research Center led to the development of an oxidation-resistant coating alloy that shows great promise for the protection of γ titanium aluminides.

Aluminizing treatments, conventional MCrAlY (M = Ni or Fe) coatings, and ceramic oxidation-resistant coatings for γ–based titanium aluminides have not proven successful because of poor mechanical properties, thermal expansion mismatch, and chemical incompatibility. Promising coating alloys have been identified in the Ti-Al-Cr system (ref. 2). These alloys exhibit excellent oxidation resistance and are generally compatible with the γ substrate alloys; however, they are brittle (ref. 2).

A Ti-Al-Cr oxidation-resistant coating alloy recently developed at NASA Lewis offers excellent substrate compatibility and some improvement in mechanical properties, without sacrificing oxidation resistance (refs. 3 and 4). The alloy composition, Ti-51Al-12Cr (in atomic percent), was selected so that the microstructure consists of the γ–phase and a minor volume of the oxidation-resistant $Ti(Cr,Al)_2$ Laves phase. By basing the coating alloy on the γ–phase, we can optimize the mechanical properties and substrate compatibility. The volume fraction of the Laves phase is kept to a minimum because it is extremely brittle.



Weight gain data for a low-pressure plasma spray Ti-51Al-12Cr coating on Ti-48Al-2Cr-2Nb exposed at 800 °C in air. At each data point, the sample was air cooled to room temperature, weighed, and returned to the test furnace. Data indicate that the coating *successfully protected the substrate from oxidation.*

The Ti-51Al-12Cr coating alloy was applied to the General Electric γ–alloy, Ti-48Al-2Cr-2Nb (in atomic percent), by low-pressure plasma spray. Oxidation tests at 800 and 1000 °C in air indicated that the coating alloy successfully protected the substrate from oxidation (see the figure). Evaluation of the isothermal fatigue behavior of coated Ti-48Al-2Cr-2Nb at elevated temperatures in air is in progress.

References

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