Thermal Shock Behaviors of NbSi$_2$/Nb/gamma-TiAl Intermetallic Compounds by Burner Heating Cycle Test

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Abstract

Gamma-TiAl intermetallic compounds (γ-TiAl) have an attractive combination of properties, including low density, high specific yield strength and stiffness, and favorable creep properties at elevated temperatures. γ-TiAl is suitable for applications such as jet-engine blades, turbocharger turbine wheels, engine exhaust valves, and aerospace thrusters. However, the oxidation resistance of γ-TiAl is weak above 1173 K in air. In a previous study, NbSi$_2$/Nb/γ-TiAl and NbSi$_2$/Nb functionally graded materials (FGMs) were prepared and their tolerances were tested by exposing them to temperatures from 1323 K to 1523 K under a vacuum and under isothermal air. The lifetime of FGM coatings of thickness more than 77 μm was 380 h at 1323 K in isothermal air.

In present study, the effects of thermal shock on gamma-TiAl (γ-TiAl) intermetallic compounds and disilicide coatings on γ-TiAl (NbSi$_2$/Nb/γ-TiAl) were evaluated by burner heating cycle methods. The burner-heating test consisted of a 1-min heating period and a 20-s cooling period. The number of cycles was 10. In the fifth cycle, the maximum surface temperatures of the γ-TiAl and NbSi$_2$/Nb/γ-TiAl samples were the same at 1570 K, and the minimum surface temperatures were 640 K and 660 K, respectively. The temperature differences obtained for the γ-TiAl and NbSi$_2$/Nb/γ-TiAl samples were approximately 900 K. After the burner heating cycle test, the γ-TiAl sample had a rough surface and a spalled scale which was expected to be a mixture of TiO$_2$ and Al$_2$O$_3$. Continuous inner oxidation layer and discontinuous outer layer were observed, and SEM and EDX cross-sections showed that these layers were approximately 4 μm and 10 μm in thickness, respectively. The NbSi$_2$/Nb/γ-TiAl sample was observed to have a smooth surface without a spalled scale. An oxidation layer was not observed on the NbSi$_2$ surface.

As results, The NbSi$_2$/Nb/γ-TiAl sample was not damaged by the burner-heating cycle test.

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