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Refurbishment of Thermally Degraded Diffusion Pt-Aluminide (PtAl) Bond Coat on a Ni-base Superalloy

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Abstract

The Ni-base superalloy components operating in the hot sections of gas turbine engines are applied with diffusion Pt-aluminide (PtAl) bond coat for enhanced oxidation resistance. During service, the components experience several thermal cycles and gas temperatures as high as 1400°C. As a consequence, the PtAl coating undergoes undesirable changes in its composition as well as phase constitution, i.e. B2-NiAl → reversible B2/$L1_0$ NiAl martensite + γ′-Ni_3Al→ γ-Ni + γ′-Ni_3Al. The oxidation resistance of the coating decreases due to continuous depletion of Al during use at high temperatures. Beyond a certain level of degradation, the bond coat becomes ineffective in terms of providing oxidation resistance. For further use of the component, the bond coat needs to be stripped and reapplied. The selective stripping of the degraded diffusion bond coat without inducing damage to the component surface is a challenging task. The present study describes a method for controlled stripping of a degraded Pt-Aluminide (PtAl) bond coat on directionally solidified Ni base superalloy CM-247LC and the subsequent reapplication of a fresh bond coat on the stripped alloy surface. The stripping parameters, i.e. composition of the acid bath and dipping time, have been optimized using intermittent observation of the surface morphology and corresponding cross-sectional microstructure of the stripped samples. The microstructure and oxidation behavior of the refurbished coating formed on the superalloy after controlled stripping were comparable to those of the virgin coating. Pitting and cavitation damage was inflicted on the superalloy surface during uncontrolled rapid leaching, and the bond coats formed on these substrates did not develop the desired microstructure and exhibited inferior oxidation resistance.

Keywords: Pt-aluminide coating; TBC; Refurbishment; Repair; Stripping; Superalloy

1. INTRODUCTION

The components in the hot sections of a gas turbine engine, such as blades and vanes, are made of Ni-base superalloy and applied with a ~100 µm thick oxidation resistant diffusion Pt-aluminide (PtAl) bond coat [1,2,3]. The oxidation resistance of the bond coat is derived by