Quarterly Management Report

WBS Element	Project Title	Contract Number	Contract Start	Contract End
	Aluminide Coatings for Power-Generation Applications	4000007035	01/21/01	04/30/04

Performer Name and Address	Principal Investigator(s)
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BUDGET AND COST REPORT

Prior Year Funds [$K]	36
Total Current Year Commitment $K]	0
Projected Current Year Costs [$K]	36

	O	N	D	J	F	M	A	M	J	J	A	S
Planned Costs	3	5	20	28	36	36						
Actual Costs	2	4	19	23	27	33						
Variance	1	1	1	5	9	3	0	0	0	0	0	0

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
TTU-2-1	Task I. Aluminide Coatings on Fe-based Alloys	09/30/04		
	• To investigate the effect of substrate compositions on the quality and oxidation performance of iron aluminide coatings			
	• To complete the study of long-term interdiffusion behavior (up to 10,000h) between iron-aluminide coatings and steel substrates			
TTU-2-2	Task II. Aluminide Coatings on Ni-based Superalloys	09/30/04		
	• To synthesize the Pt-enriched gamma + gamma prime two-phase coatings			
	• To study the cyclic oxidation behavior of the Pt-enriched gamma + gamma prime coatings			

TECHNICAL HIGHLIGHTS

Task I – Aluminide Coatings on Fe-Based Alloys

• The effect of cycle length on the oxidation performance of iron aluminide coatings has been studied

One of the lifetime issues of particular concern for application of iron aluminide coatings is the possible compatibility problems between iron aluminide coatings and substrates which can have substantially different coefficients of thermal expansion (CTEs). This difference could cause deformation or cracking and reduce coating lifetime. The present study has focused on the effect of cycle length (1h vs. 100h) on the cyclic oxidation behavior of aluminide coatings on representative commercial ferritic (Fe-9Cr-1Mo) and austenitic (type 304L stainless steel) alloys at 700°C in air with 10 vol.% H2O. The ferritic and austenitic steel specimens were aluminized in a laboratory-scale chemical vapor deposition (CVD) reactor in order to more rigorously control the coating process in terms of coating composition, purity and microstructure. The as-coated aluminide coatings on both alloys typically consisted of a relatively thin (20-25 microns) Al-rich outer layer Fe3Al and a thicker (150-250 microns) inner layer with less Al. After 2000, 1h cycles at 700°C in air + 10 vol. H2O, the coatings on both alloys showed significant cracking and/or deformation; at one location the attack to the substrate alloy was noticed. However, for the same coatings, no such degradation was observed after exposure to a longer cycle time (100h), e.g.,after 40, 100h cycles (total 4,000h) in the same environment at 700°C. These testing results indicated that high frequency thermal cycling (1h cycle time) could significantly degrade the coating performance. Comparison of the Al composition profiles in the coating specimens after cyclic exposures to different cycle lengths (1h. vs. 100h) with those after isothermal exposure in laboratory air showed that this degradation was not due to Al loss from the coating into the substrate by interdiffusion. It was most likely caused by the thermal expansion mismatch between the coating and substrate. The results have been summarized and submitted to Surface and Coatings Technology for publication.

• Presented a paper entitled “Effect of Cycle Length on the Oxidation Performance of Iron Aluminide Coatings” (by Y. Zhang, B. A. Pint, G. W. Garner, K. M. Cooley, and J. A. Haynes) at the International Conference of Metallurgical Coatings and Thin Films (ICMCTF), San Diego, April 19-23, 2004

Task II – Aluminide Coatings on Ni-Based Superalloys

• Two-phase microstructure g+g’ was obtained by annealing Pt-plated René 142 coupons in vacuum at 1100-1200°C

René 142 coupons were electroplated with a thin layer of Pt of approximately 7 microns in a laboratory plating system developed at Tennessee Technological University (TTU). The Pt-plated specimens were annealed in a vacuum furnace for 2h at three different temperatures, 1100, 1150 and 1200°C. After annealing, the specimens were examined by light microscopy, field-emission gun scanning electron microscopy (FEG SEM) equipped with energy dispersive X-ray analysis (EDXA) and electron probe microanalysis (EPMA) using wavelength dispersive X-ray analysis. The two-phase microstructure was clearly shown on the back-scattered images after the annealing treatment at all three temperatures. However, when the annealing was conducted at 1100°C, the two phases appeared to be quite blocky, while at 1200°C, the substrate microstructure seemed to be affected and more Kirkendall voids were observed between the coating and the substrate. The annealing temperature was therefore selected at 1150°C, which was consistent with the oxidation testing temperature for platinum aluminide coatings. At this annealing temperature, the EPMA indicated that the average Al and Pt concentrations were at the similar level, ~ 18at.%, while Ni was ~45at.%. Cr and Co were incorporated in the two-phase coating, ~8at.%. The levels of the refractory metals such as Ta and W were higher than in the traditional beta (Ni,Pt)Al coating, ranging from 2 to 3at.%; this was due to high partitioning of these elements in the g’ phase.

(Note that g+g’ stands for gamma + gamma prime.)

ISSUES

Report Prepared By	Date
Ying Zhang	05/26/04