Quarterly Management Report

WBS Element	Project Title	Contract Number	Contract Start	Contract End
	Novel Processing of Mo-Si-B Intermetallics for Improved Efficiency of Power Systems	W-7405-ENG-82	06/01/00	09/30/05

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

Prior Year Funds [$K]			36									
Total Current Year Commitment $K]			186									
Projected Current Year Costs [$K]			160									
	O	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**
Planned Costs	13	27	40	53	67	80	93	107	120	133	147	160
Actual Costs	10	24	38									
Variance	4	3	2	53	67	80	93	107	120	133	147	160

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
	Thermal barrier coating development	01/30/04		
	Alloy oxidation in synthetic combustion atmosphere	04/30/04	09/30/04	
	Nb-Mo-Si-B alloy development	07/30/04	09/30/04	
	Control of low temperature catastrophic oxidation	09/30/04	09/30/04	

TECHNICAL HIGHLIGHTS

Thermal barrier coating development

All materials, including Mo-Si-B powders to be plasma sprayed and Mo sheet for use as the substrate, have been sent to INEEL. They have tentatively scheduled spraying to begin the week of February 2nd. Ames will begin the annealing experiments of the sandwich structures upon receipt of the sprayed structures from INEEL. We hope to have initial results to report for the second quarter report.

Alloy oxidation in synthetic combustion atmosphere

Previous work has shown that the Mo-rich Alloy 3 in wet nitrogen failed to macroscopically passivate as the alloy continued to lose mass at an estimated rate of 1.7 mg/cm2/hr over the entire test duration of 100 hours. Isothermal oxidation tests have been completed to further understand the role that water vapor may play in the oxidation of the alloys. The table below gives results for tests at 1000°C.

Alloy tested	Conditions	Mass loss rate (mg/cm2/hr)
Alloy 3	Nitrogen with water (150 Torr)	- 1.4
Alloy 3	Nitrogen with water (355 Torr)	- 2.3
Alloy 3	Dry Air	-2.5 x 10 -3
Alloy 3	Air with water (150 Torr)	-2.3 x 10 -3
Alloy 3	Argon with water (150 Torr)	-8.2 x 10 -2 (batch run)
Alloy 1	Nitrogen with water (150 Torr)	- 0.33
Alloy 1	Dry Air	-2.3 x 10 -3
Alloy 1	Air with water (150 Torr)	-3.7 x 10 -3

The above results suggest that nitrogen in combination with water has a significant role in the oxidation process. While passivation is attained in both dry and wet air, significant mass loss rates are observed in alloys both rich in Mo (Alloy 3) and those richer in Si (Alloy 1). Also note the reduced rate for oxidation in wet argon. Moreover, the alloys do not undergo the characteristic large mass loss on initial heating through the volatilization temperature of about 650-750°C. Further tests in dry nitrogen (ie- low PO2 values) are planned to better understand whether water vapor or a low PO2 nitrogen gas environment is the dominant effect. We will also continue with refinement of thermodynamic modeling and experimental verification of formation of Mo2N to better describe this behavior and plan to report these results in the second quarter report.

Nb-Mo-Si-B alloy development

The chlorination process has been approved by the Safety Review Committee. The idea is to convert the Nb2O5 component within the oxide scale into a volatile NbCl5 phase which condenses downstream of the sample in a water bath. Initial qualification experiments have been completed and experimental conditions have been appropriately determined for the process. The reaction was demonstrated by exposing 100 mg of Nb2O5 powder to a chlorine and carbon monoxide gas mixture at 1000°C and attaining a 98.5% removal in 30 min. This amount of Nb2O5 is the typical amount expected in a pre-oxidized sample of the quaternary alloy. We also demonstrated that borosilicate glass, a component of the oxide scale, is resistant to the chlorination process as it experienced a negligible mass loss of 1% under the same exposure conditions. We will report our initial results on the chlorination of oxidized quaternary alloy in the second quarter report.

Control of low temperature catastrophic oxidation

The proposed concept is to form non-volatile molybdates on the surface of the oxidizing alloys through the following reaction: AO + MoO3 ==> AMoO4, where A is one of the alkaline earth metals Mg, Ca, Sr, or Ba. This reaction is envisioned to inhibit the catastrophic oxidation of the alloys which is known to occur between about 650°-750°C. We will perform a thermodynamic analysis of this concept, first to determine the spontaneity of the reaction between 600°-800°C. The formation of the molybdate must be favorable and rapid in comparison to the rate of formation of MoO3. We will also evaluate the expected volume change for the reaction. Large volume increases may promote spalling of the product and a loss of protective behavior. We will report these results in the second quarter report.

ISSUES

Last quarter we reported that the postdoctoral scientist working on the project concluded his employment on 7/30/03 and that a high quality doctoral graduate student was hired. Unfortunately, that student has withdrawn from the university for personal reasons. We will recruit a replacement graduate student.

We are revising the due dates for the first three milestones to 09/30/04. Our research team is working simultaneously on all 4 tasks as opposed to serially, and thus it was an oversight last quarter to report due dates prior to 09/30/04.

Report Prepared By	**Date**
Andrew J. Thom	01/30/04