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)
Dr. Patricia Thiel 321 Spedding Hall Iowa State University Ames, IA 50011	Dr. Matthew J. Kramer Dr. Mufit Akinc Dr. Andrew J. Thom

BUDGET AND COST REPORT

Prior Year Funds [$K]	36
Total Current Year Commitment $K]	186
Projected Current Year Costs [$K]	160

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Planned Costs	13	27	40	53	67	80	93	107	120	133	147	160
Actual Costs	10	24	38	51	65	79						
Variance	4	3	2	2	2	1	93	107	120	133	147	160

MILESTONE REPORT

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

TECHNICAL HIGHLIGHTS

Second Quarter Highlights

Alloy oxidation in synthetic combustion atmosphere

Experimental work on this milestone has been completed. The results of this work were presented at the Spring 2004 TMS conference on "Beyond Nickel-Base Superalloys". We will conclude this work by writing and submitting a manuscript to a referred journal such as Intermetallics.

Nb-Mo-Si-B alloy development

Experimental work on this milestone has been completed. The results of this work were also presented at the Spring 2004 TMS conference on "Beyond Nickel-Base Superalloys". The results of this work were submitted as a proceedings article to this conference, and will be published in Metallurgical and Materials Transactions A.

Following are the salient results of this work, taken from the summary of the above manuscript:

Results showed the formation of a mixed Nb-Mo oxide solid-solution at lower temperature on exposure to air. This oxide solid-solution dissociated to Nb_2O_5 and MoO_3 at higher temperature. MoO_3 then volatilizes to leave large pores in the external scale. Fine-grained Nb_2O_5 is distributed throughout the borosilicate glassy scale component, which increases the viscosity of the glass to interfere with the formation of a continuous glass. A new chlorination treatment of the oxidized alloy was used to remove the non-volatile Nb_2O_5 from the oxidized scale and obtain a scale rich in borosilicate glass. Chlorination was able to remove Nb_2O_5 from most of the scale on the 5 hours pre-oxidized alloy. Oxidation rates were reduced by two-thirds after the chlorination treatment. Steady state parabolic rate of oxidation after chlorination treatment was comparable to that of alloy oxidation in regular argon. Low oxidation rates after chlorination indicates the formation of a protective scale. This also suggests that oxidative instability of Nb-Mo-Si-B alloys can be attributed to presence of non-volatile Nb_2O_5.

Thermal barrier coating development

We received the plasma sprayed Mo sheet samples from INEEL this quarter. We will begin work on annealing, oxidation testing, and analysis of the samples in the third quarter.

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: $AO + MoO_3 \Longrightarrow AMoO_4$, 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 completed our thermodynamic analysis of this concept, and have determined that Ca is the best alloy additive for testing this concept. Our initial results show that the Ca additive reduces, but does not eliminate, the pesting reaction in air at 700°C. This is based on the oxidation of a Ca-containing Alloy 3 (Mo-T2-Mo3Si) pellet at 700°C in air. The mass loss of the Ca-modified alloy was 150 mg/cm2 after a 10 hour exposure. This compared favorably to the standard alloy, which lost 220 mg/cm2 after only a 1 hour exposure. The Ca-modified pellet was significantly less than full density (about 80% of theoretical), and this increased surface area certainly contributed to an increased extrinsic oxidation rate of the sample. Initial EDS analysis shows that Ca is present in the alloy, and work is underway to: (1) increase the Ca level in the alloy, (2) increase the sintered density of the Ca-modified alloy, and (3) perform a detailed structural analysis to determine the location and effect of Ca in the multiphase Mo-T2-Mo3Si alloy.

ISSUES

We have hired a high quality doctoral graduate student to replace the student that withdrew from the university on 12/30/04.

We have revised the quarterly due dates as agreed to in our 03/05/04 email to Richard Read. This has us completing on time our first two milestones. We further propose to interchange the due dates on the thrid and fourth quarter milestones to more accurately reflect our current progress towards those two milestones, and these revisions are reflected in the "Revised Due Date" column on the first page of this report.

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