Quarterly Management Report

WBS Element	Project Title	Contract Number	Contract Start	Contract End
ORNL-2(I)	Nanoprecipitates in Steels	FEAA028	10/01/06	09/30/07

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

Prior Year Funds [$K]	22
Total Current Year Commitment $K]	128
Projected Current Year Costs [$K]	150

	O	N	D	J	F	M	A	M	J	J	A	S
Planned Costs	12	25	37	50	62	75	87	100	112	125	137	150
Actual Costs	5	25	36	47	55	72						
Variance	7	0	1	3	7	3	87	100	112	125	137	150

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
ORNL-2(I)-1	Determine size of oxide particles in an internally oxidized Fe-Y-Ti solid solution	03/31/07		03/31/07
ORNL-2(I)-2	Determine size of oxide particles in an internally oxidized Fe-Y-Ti intermetallic	09/30/07		
ORNL-2(I)-3	Determine the influence of Cr and W additions on the size of oxide particles in an internally oxidized Fe-based solid solution	03/31/08		
ORNL-2(I)-4	Determine the influence of Cr and W additions on the size of oxide particles in an internally oxidized Fe-based intermetallic	09/30/08		
ORNL-2(I)-5	Procure alloy powder, oxidize internally, and consolidate by extrusion	03/31/09		
ORNL-2(I)-6	Determine creep properties of extruded steel	09/30/09		

TECHNICAL HIGHLIGHTS

Several Fe-Ti-Y solid solutions and intermetallic compounds were prepared by arc-casting in a partial pressure of argon followed by internal oxidation to form Ti-Y-O dispersoids. The internal oxidation was performed in two ways. In the first approach, alloy powder was mixed with a suitable amount of Fe_2O_3 (to provide the oxygen needed to form the Ti-Y-O dispersoids) followed by annealing in vacuum. In the second approach, alloy coupons were vacuum-encapsulated in quartz together with an adjacent Fe-Fe_2O_3 powder mixture ("Rhines pack) providing the appropriate oxygen partial pressure and subsequently annealed. The second approach resulted in an internally oxidized zone typically 20 to 50 micrometer thick. The size of the dispersoids that formed during the internal oxidation was analyzed on carefully polished metallographic sections using a high-resolution scanning electron microscope (SEM).

Fe-0.8Ti-0.4Y (at%) solid solution alloy powder was internally oxidized by mixing with Fe_2O_3 powder and vacuum annealing for 24 h at 1000C. Ti-Y-O particles as large as 1 micrometer formed, but there were also numerous particles with sizes on the order of 100 nm. Internal oxidation was also performed by annealing for 3 days with a Rhines pack at lower temperatures. Annealing at 800C and 700C resulted in particle sizes of ~100 nm and ~50 nm, respectively. These experiments show that very small particles can be produced. Future experiments will have to address the stability of these particles against coarsening during prolonged annealing.

Internal oxidation experiments were also carried out with $Fe_{17}Y_2$ and $Fe_{11}YTi$ intermetallics. After pulverization, these intermetallic powders were mixed with a suitable amount of Fe_2O_3 and annealed for 24 h at 1000C in vacuum. Similar to the solid solution alloys, the maximum particle sizes were ~0.5 to 1 micrometer. Annealing with a Rhines pack for 3 days at 700C resulted in much smaller sizes. In the $Fe_{11}YTi$ intermetallic, a volume fraction of ~50% of ~20 nm diameter particles was identified. In the $Fe_{17}Y_2$, a ~50% volume fraction of ~10 nm thick lamellae was found. These sizes approach the size scale typical for one of the best ODS steels, PM2000, which contains ~10 nm diameter $YAlO_3$ dispersoids. Again, the stability of the Ti-Y-O dispersoids against thermal coarsening needs to be examined.

ISSUES

None

Report Prepared By	Date
Joachim H. Schneibel	05/03/07