Quarterly Management Report

WBS Element	Project Title	Contract Number	Contract Start	Contract End
UCSD-2	Oxide Dispersion Strengthened Fe3Al Based Alloy Tubes: Application Specific Development for Power Generation Industry	19X-SY09C	12/08/97	04/07/04

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

Prior Year Funds [$K]	305
Total Current Year Commitment $K]	45
Projected Current Year Costs [$K]	75

	O	N	D	J	F	M	A	M	J	J	A	S
Planned Costs	350	350	350	350	350	350	350	350	350	350	350	350
Actual Costs	298	304	310									
Variance	52	46	40	350	350	350	350	350	350	350	350	350

MILESTONE REPORT

Milestone Designation	Milestone Description	Due Date	Revised Due Date	Completion Date
1.1	Base ODS-Powders, alloy chemistry, Fe/Al ratio, alloy additions Dispersoids: chemistry, matrix compatibility	06/30/02		06/30/02
1.2	FAS compositions, scale and distributions for functionally gradient tubes	09/30/02		12/31/02
2.1	Milling process optimization, powder strain state characterization	12/31/02	03/31/03	03/31/03
2.2	primary extrusion consolidation: process parameters for tubes & sheet processing; Explore functionally gradients sheets & tubes	12/31/02	06/30/03	06/30/03
2.3	initial material strength, texture and anisotropy evaluation	03/31/03	06/30/03	06/30/03
2.4	Static Recrystallization Kinetics of task 2.2 and materials	06/30/03	09/30/03	09/30/03
2.5	Gradient Recrystallization schemes of task 2.2 materials	06/30/03	09/30/03	09/30/03
3.1	Mechanical strength: uniaxial and biaxial loading assessmen	09/30/03	12/31/03	12/31/03
3.2	Creep Performance: longitudinal and transverse loading assessment	12/31/03	03/31/04	

TECHNICAL HIGHLIGHTS

CREEP TESTING: Hoop Creep of ODS-Fe3Al Alloy Tubes

Long duration creep-life evaluation and stress-rupture testing is being performed on four creep-testing rigs (maximum test temperature = 1200degC) installed at UCSD during the course of this research program.

Test matrices are currently exploring threshold stress capabilities of transversely oriented specimens. Transverse creep specimens are extracted from as-extruded 1-3/8" OD tubes as follows: the tubes are split along their length by wire EDM, and then hot press-forged (single step) flat and/or rolled flat at 900degreesC. ASTM E-8 specimens are then spark machined from the forged piece. The machined test specimens are then subjected to a series of high temperature secondary recrystallization heat-treatments (over a range of time temperature combinations in different environments) prior to the incremental stress rupture tests. At the outset the bulk of the tests are conducted in air in the 900 - 1000 degrees C temperature range.

A threshold stress of 6ksi has been recorded for tests conducted at 900 degrees C. The argon recrystallized as well as the cross-rolled and air recrystallized specimens failed at the 6ksi stress level following a 516hours and 523 hours exposure, respectively. The strain vs. time plots show a range of steady state creep rates depending on the specifics of thermal-mechanical treatment. Both tests were started at 3ksi with a 1ksi stress increment after 1000hours at each stress level, i.e., each test survived a 1000hour exposure up to the 5ksi level. Repeated tests were conducted at a fixed 5ksi stress - and no failure was observed after 4453 hours of exposure in air.

A threshold stress of 2.5ksi has been recorded for PMWY-3 chemistry in creep tests conducted at 1000 degrees C. These samples were recrystallized in an inert argon atmosphere. The strain vs. time plots indicated an initial transient creep rate of 3e-4/day followed by a steady state creep rate of 1e-4/day. After an initial exposure of 4370 hours at 2ksi, the stress was raised to 2.5ksi and exposed for another 1200 hours and then terminated. The sample cross section has been preserved for TEM examination of intra-grain vis-a-vis grain boundary deformation substructure.

CROSS-ROLLED SAMPLES: transverse rolled specimens (recrystallized in air) exhibit improved performance with a lower overall steady-state creep rate. These tests are continuing at present with about 500 hour exposure at 2.5ksi.

NON FUSION JOINING of MA956 TUBES

Recent efforts include inertia welding of ODS-alloy tubes to validate this technology for possible end-use applications. Initially MA956 tubes have been used to produce robust butt configuration joints in 2-1/2" OD -1/4" wall thickness tubes. Optical microstructures reveal a 1-3mm region (along the tube axis) of intense material flow at the joint interface. the width of the Heat Affected Zone (HAZ) is dictated by the energy input and upset conditions employed in the inertia welding process. Mechanical properties have been examined in the as-welded state as well as after recrystallization treatment. Tensile tests of as-welded materials indicate that the sample fails at the joint interface at about 90-95% of the matrix yield strength with low ductility. However, in recrystallized specimens the matrix fails after significant ductility. TEM examinations reflect the fine grained nature of the joint region which is unchanged after the recrystallization treatment.

CREEP TESTING: MA956 JOINTS

Two separate inertia welding test conditions are being examined presently. The operating variable is the upset applied to the joint.

Longitudinal sections were cut (with the joint region well within the sample gage length) and tested in air at a constant load (2ksi initial stress) over the 700-900degC range. The sample failed upon loading (life = 2.4hrs) at 900degC. At 800degC the test lasted 128 hours. At 700degC negligible strain was recorded after 200 hours and this test ran for 982 hours prior to failure. The creep rates observed (in the order of increasing temperature) are 4e-5, 3.8e-3 and 4e-1 respectively for the higher upset test joints. The steady-state creep rate vs. temp. (or 1/T) is linear which yields an activation energy of the order of 437kJ/mole.

Results show that joint creep performance can be varied by controlling the inertia welding parameters. For example a remarkable improvement in observed creep rates is noted in joints with lower upset. This test matrix is being completed and will be reported on later.

ISSUES

Report Prepared By	Date
Bimal K. Kad	01/30/04