INL-University Consortium for High Temperature Materials

University Principal Investigators

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Background

- NGNP heat exchanger will be a critical component
- Ist generation HX will be metallic
- Current metallic materials will be at their limit of usefulness
- Material will experience wide range of conditions
  - Temperature RT-~ 1000°C, gradients
  - Environment-slightly oxidizing under normal conditions, potentially carburizing-off normal
  - Mechanical-static, cyclic

NGNP HX Materials Program

- Focused on Alloy 617
  - Code Case Data Generation
  - Alloy Characterization
  - Focused on high temperature regime
- "Backup" Alloy-Alloy 230
  - Potentially more consistent properties
  - Very little data available
  - Code case not initiated
- In BOTH Cases
  - Much more is needed over the entire operating temperature range

Gaps

- Characterization of Alloy 617 over entire temperature range of operation
  - All potential phenomena
- Characterization of Alloy 230 in general
  - All potential phenomena

Collaboration Focus

- Focus on Alloy 230
- Smaller Effort on Alloy 617
- More Science Based
- Complete Temperature/Phenomena Range

Temperature Range/Phenomena

- 800-950°C (or higher)-Rapid Stress Relaxation
  - Creep, creep-fatigue
  - Environmental effect on initiation
- 700-850°C-Limited Stress Relaxation
  - Fatigue, creep-crack growth
  - Environmental effect on initiation & propagation
- 600-750°C-Little Stress Relaxation
  - Fatigue, SCC (SAGBO)

INL-University Collaboration

- Builds on existing research related to HX materials
  - MIT-LDRD focused on alloy 617 in 600-850°C range
  - BSU-LDRD focused on microstructural evolution during creep-fatigue
  - Illinois-NERI on modeling high temperature behavior
  - UNLV-program on materials for hydrogen production

INL-University Collaboration (Cont.)

- Magnifies overall effort
  - Sharing of students
    - UNLV-INL
    - BSU-INL
    - MIT-INL
  - Magnifies Resources
    - UNLV contributes funding for student (BSU) and specimen fabrication
  - Magnifies "Competence"
    - Sharing of test facilities
    - Sharing of test methods

INL-University Collaboration (Cont.)

- Value to INL/National Program
  - Strengthens INL-University Relations
  - INL Staff/University involvement
    - Student supervision
  - Student involvement
    - Laboratory involvement
  - Attracts potential new employees
  - R&D Value

INL-University Collaboration (Cont.)

- Value to University
  - Allows for use of existing strengths
  - Expands “competence”
  - Student/INL/Faculty interaction
  - Inter-University Collaboration

Current Status

- Areas/Roles defined
- Information/Hardware Exchange
  - DCPD hardware
  - DCPD software
- Student support in place
  - BSU
- Test Matrix Established, Specimens in machining

Individual Collaborator Emphasis and Relationships

Team Member	High Temp.*	Int.-High Temp.**	Int. Temp.***	Creep (Air)	Creep [f(PO_2)]	Creep Crack Growth (Air)	Creep Crack Growth [f(PO_2)]	Creep-Fatigue (Air)	Creep-Fatigue [f(PO_2)]	Fatigue/ Static (SCC) (Air)	Fatigue/ Static (SCC) [f(PO_2)]	Microstructure Modeling Microstructure Evolution	Cracking Modeling	Constitutive Modeling
MIT		X(4)	X	P(3)	P	C(2)	L(1)	P	P	C	L	C	L	C
BSU		X	X	P	P	L	C	P	P	L	C	L	C	C
UNLV	X			L	C	C	C	C	C	P	P	P	P	P
INL	X			C	L	P	P	L	L(5)	P	P	C	C	C
UIUC	X	X		C	L	C	C	C	C	C	C	C	C	L

* 800-1000°C
** 700-850°C

Illinois

UNLV

Student Funding

MIT ($f(P_{O2})$), BSU (air)
Equipment & Software Sharing

Specimen Matrix

Test	Specimen Type	Drawing Identifier	Machining Method	INL	MIT	UNLV	BSU	Illinois	Specimen Totals
Creep	Creep	NGNP 1-1	Turn/Grind	10/5[(1)]	-	20/10	-	5/5	35/20
Stress Rupture	Notched Creep	NGNP 4-1	Turn/Grind	15/5	5/5	15/5	-	5/5	40/20
Tensile	Tensile	NGNP 1-1	Turn/Grind	5/5	5/5	5/5	5/5	5/5	25/25
Creep-Fatigue	Creep-Fatigue	NGNP 3-1 (Long)	Turn/Grind	15/5	-	10/5	-	-	25/10
Crack Growth-Static	Compact Tension	NGNP 5-2	Wire EDM	10/5	15/10	10/5	10/5	-	45/25
Creep Crack Growth	Compact Tension	NGNP 5-2	Wire EDM	10/5	15/10	5/2	10/5	-	40/22
Special Alloy	Compact Tension	NGNP-5-2	Wire EDM		15[(3)]	15[(3)]			30
Special Alloy	Tensile	NGNP-1-1	Turn/Grind		15[(3)]	15[(3)]			30
Totals				65/30	40/30	70/32	25/15	15/15	200/117

(1) # Alloy 230 Specimens/# Alloy 617 Specimens

Path Forward

- Begin Testing
- Student Exchange
- Visibility
  - Joint Publications
  - Conferences
- Become more integrated with base NGNP Materials Program

Measures of Success

- Student/INL Involvement
- Joint Publications
- Significant Additions to Data/Literature
- Engagement with NGNP Materials National Program