

So Now, What?

Collaborative Pathways Forward

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Disclaimer

Ferritic ODS Alloys Workshop

November 18, 2010

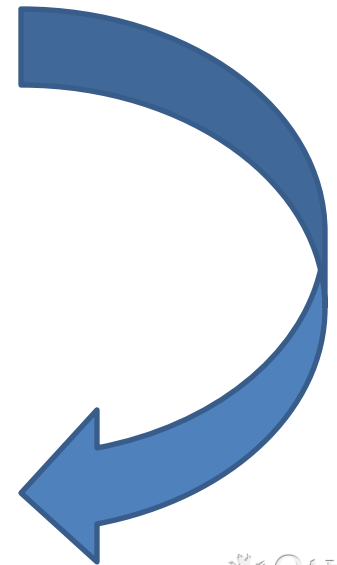
Time Is Right to Advance ODS Alloys as Part of Push for Higher Temperature Materials

- Energy efficiency imperative
- Existence of foundational knowledge and experience
- Recent progress
 - Joining
 - Processing know-how available for producing powder, tubes, sheet, and near net shaped products
 - Understanding of scale failure modes and credible prediction methodologies for oxidation lifetimes
 - Abilities to design, control, characterize at smaller length scales so as to impact macroscopic behaviors

Fully Cognizant of the Problems, Pathways for Moving ODS Alloys Forward

- More and more integrated R&D
- Cooperative Research and Development Agreements (CRADA's)
- Bilateral or multi-lateral working agreements
- Component or subcomponent ("Build Something") project(s)
- Program focused on scalability, energy efficient manufacturing processes, and establishment of supplier base
 - R&D
 - End users
 - Materials and component suppliers

**There are Examples of Where
This Has, and Is, Being Done.**



DOE's Science to Energy Pathway

Discovery Research

- Basic research for fundamental new understanding on materials or systems that may be only peripherally connected or even unconnected to today's problems in energy technologies
- Development of new tools, techniques, and facilities

Use-inspired Basic Research

- Basic research for fundamental new understanding, with the goal of addressing short-term showstoppers on real-world applications in the energy technologies

Applied Research

- Research with the goal of meeting technical milestones, with emphasis on the development, performance, cost reduction, and durability of materials and components or on efficient processes
- Proof of technology concepts

Technology Maturation & Deployment

- Scale-up research
- At-scale demonstration
- Cost reduction
- Prototyping
- Manufacturing R&D
- Deployment support

BES

Goal: new knowledge / understanding
Mandate: open-ended
Focus: phenomena
Metric: knowledge generation

Applied Energy Offices
EERE, FES, NE, FE,

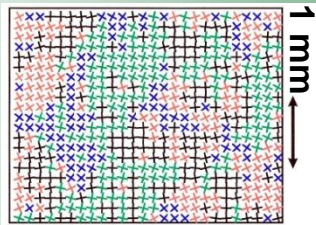
Goal: practical targets
Mandate: restricted to target
Focus: performance
Metric: milestone achievement

Superconductor Wires: From Lab Discovery to Commercialization.

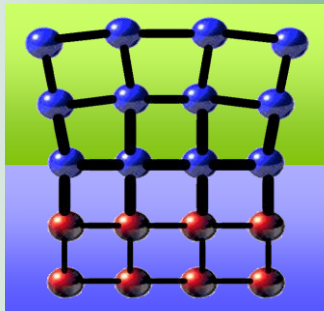
Basic Science

(Office of Science)

Grain-to-grain current flow:



Single crystal film formation:



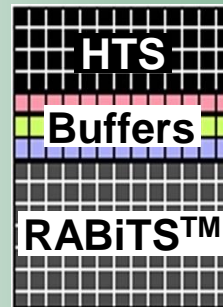
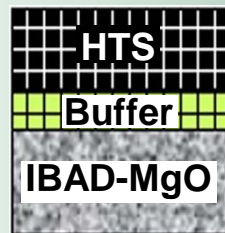
Applied R&D

(Office of Electricity Delivery & Energy Reliability, EERE)

Single crystal-like template by the kilometer (RABiTS™):



Epitaxial buffers for high-performance 2G HTS wires:



Manufacturing & Commercialization

- ✓ Licensed to both major U.S. wire manufacturers.
- ✓ Only 2G HTS wire suppliers in the world.
- ✓ International customers.



- Core template & buffer technologies of AMSC wire.



- Key buffer component of SuperPower wire.

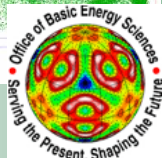
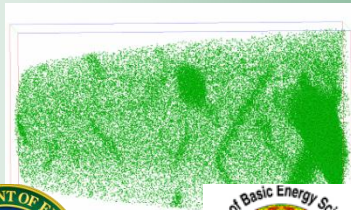
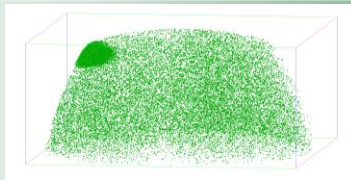


Rapid Infrared Heating Technology: From Lab Discovery to Commercialization

Basic Science

(NSF & DOE OS)

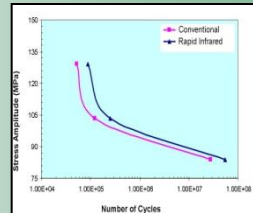
Atom probe results showing finer distribution of nano-size Al_2CuMg precipitates in Infrared heated forgings:



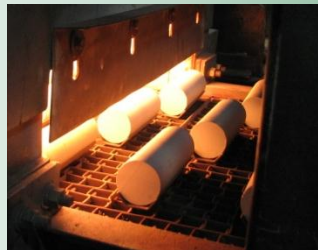
Applied R&D

(EERE Industrial Technologies and DOE Fossil Energy)

Finer precipitate distribution improves fatigue life:



Preheating of Aluminum Billets



U.S. Department of Energy
Energy Efficiency
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TAPPING THE FULL POTENTIAL OF AMERICA'S TRADITIONAL ENERGY RESOURCES

Manufacturing & Commercialization

✓ Full-scale production based infrared furnace operating at Queen City Forging Company.



✓ Machined impellers for diesel turbochargers, over one million made



CF8C-Plus Cast Stainless Steel: From Lab Discovery to Commercialization

Scientific Understanding

(FE, EERE Vehicles and Industrial Technologies & TCDF)

Alloy compositional design - stable austenite matrix and nano-carbide/nitrides
Creep resistant at 600-900C, with ductility and fatigue resistance
Superalloy performance at a stainless steel price (5-7 times less)

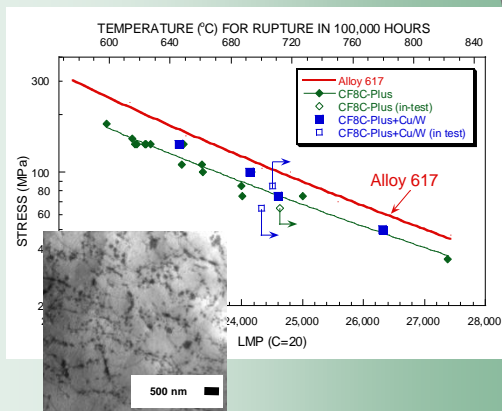
Technology Development

- 18 months from lab to commercial heats
- 2003 R&D 100 Award
- 2007 ASTM Approval
- 2009 Federal Laboratory Consortium Tech Transfer Award



Manufacturing & Commercialization

- ✓ Caterpillar Regeneration System burner housings on diesel trucks; over 500 tons cast and over 10,000 parts in service with no reported failures since 2006
- ✓ Qualifying CF8C-Plus for turbocharger housings
- ✓ ITP ARRA project accelerates deployment of CF8C-Plus for new energy-relevant applications



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U.S. Department of Energy
**Energy Efficiency
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Honeywell



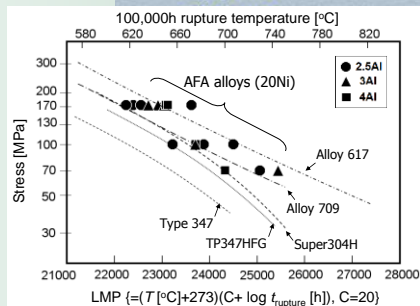
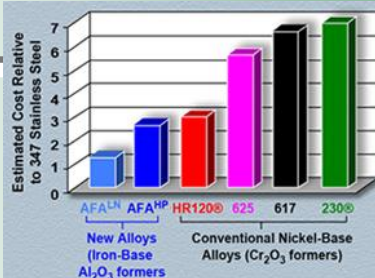
OAK
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Alumina Forming Austenitic Stainless Steel From Lab Discovery to Commercialization

Scientific Understanding

(FE Advanced Research Materials, ORNL LDRD)

- AFA Stainless Steels: superior oxidation and creep resistance vs. commercial heat-resistant steel alloys at elevated temperatures
- External Al_2O_3 protective oxide is stable in the presence of H_2O



Technology Development

(EERE Industrial Technologies [ITP])

- Able to fabricate in plate, foil, and wire shapes by conventional processing
- CRADAs to evaluate AFA foil for turbine recuperator applications
- 2009 R&D 100 Award

Solar Turbines

A Caterpillar Company



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FOSSIL ENERGY
TAPPING THE FULL POTENTIAL OF AMERICA'S TRADITIONAL ENERGY RESOURCES

Manufacturing & Commercialization Goals

- ✓ Increasing the efficiency and/or durability of turbines for CHP with no cost increase from current alloys
- ✓ Property database for extended applications
- ✓ Cost-shared commercial demonstrations

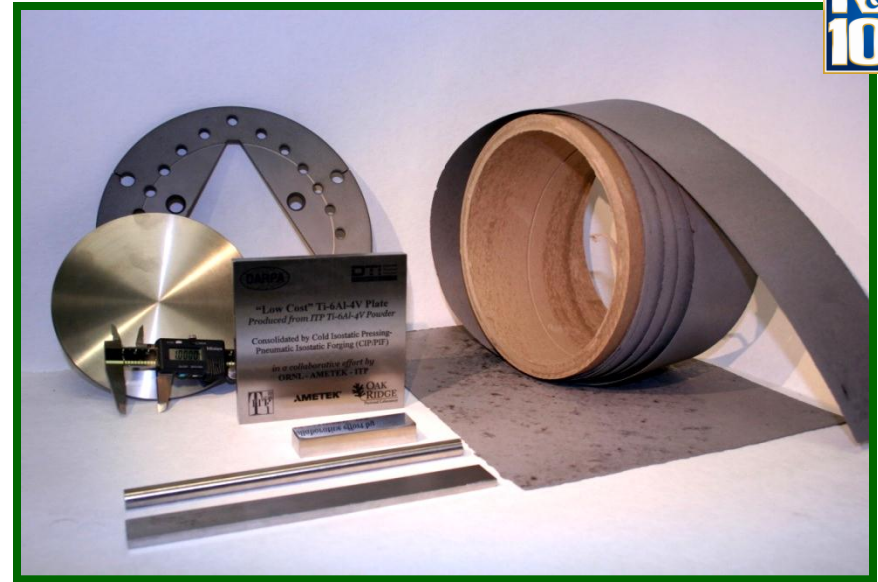


U.S. Department of Energy
Energy Efficiency and Renewable Energy



Solid State Consolidation of “Low-Cost” Ti Powders and Near-Net Shape Processing

- ORNL Is collaborating with industry to develop solid-state processing required for consolidating new low -cost titanium powders
 - extrusion for bar
 - roll compaction for sheet
 - hot isostatic forging, press and sinter, vacuum hot pressing, and pneumatic isostatic forging for plate and near-net shapes
- Reduced cost of plate, sheet, and near-net shapes by 50 to 90%
- Reduced Scrap from 50% for conventional material to <5% for new low-cost titanium
- Demonstrated and exceeded “wrought” material performance parameters



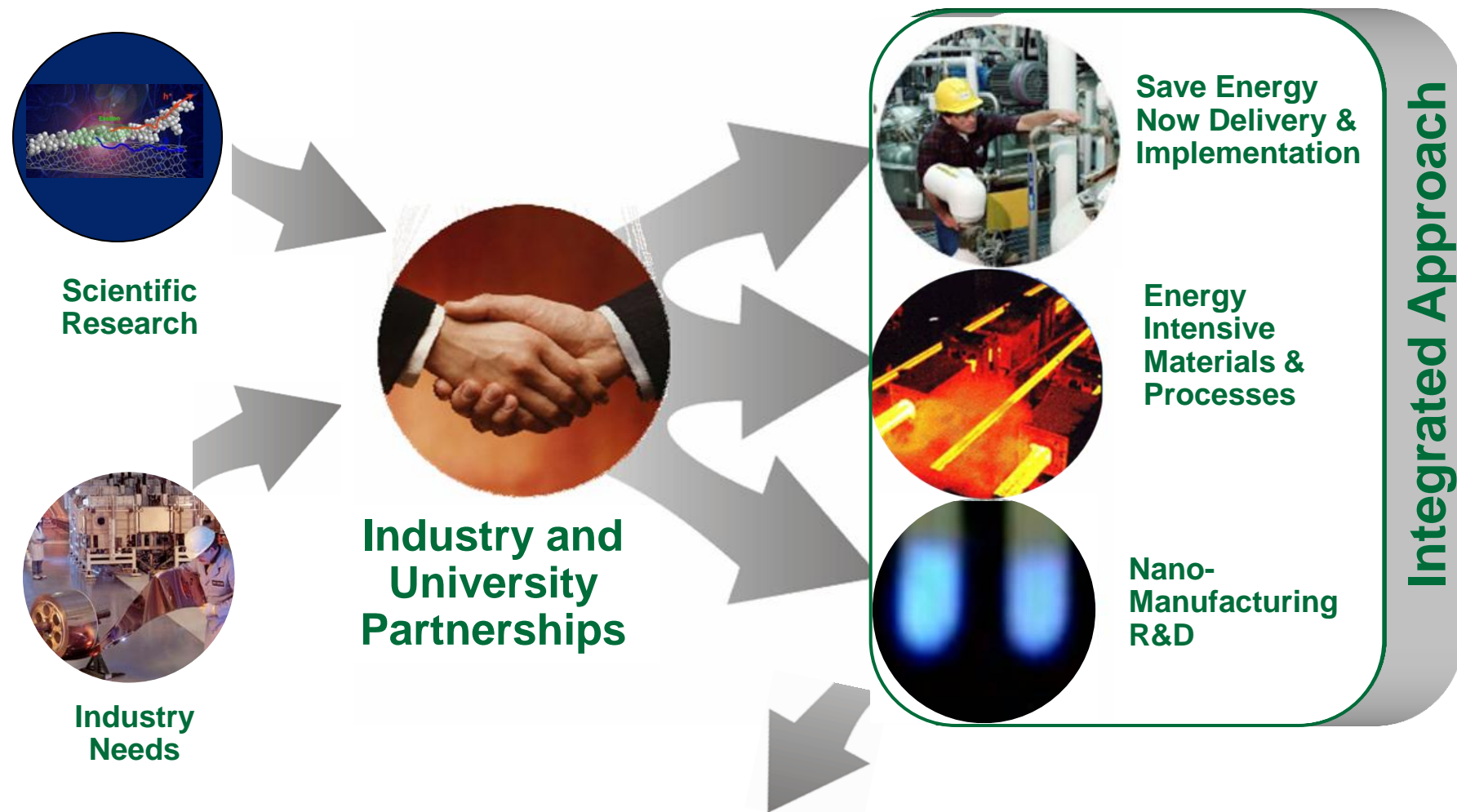
Solid State Consolidated Plate, Bar, Sheet, and Net Shape Components Produced from New “Low Cost” Titanium Powders



Front and back of V₅₀-tested vacuum-hot-pressed Ti-6Al-4V

DOE's Industrial Technologies Program (ITP)

Providing integrated solutions to accelerate innovation to industrial deployment



Decreasing Industrial Energy and Carbon Intensity

Increasing U.S. Industrial Competitiveness

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