The Fossil Report

Oak Ridge National Laboratory Fossil Energy Program Winter 2002

Energy Technology for the Future...and for the World

IN THIS ISSUE

New Work Focuses on Materials Needs for USC Steam Cycle Turbine
Interest Grows For Fibrils In Commercial Applications
Tom Schmidt Retires
Argonne Continues Work On NDE For Thermal Barrier Coatings
Electronic Reporting Takes A Step Forward
New Technique For Applying Thermal Barrier Coatings Under Development At ORNL

New Work Focuses on Materials Needs for USC Steam Cycle Turbine

A six-year project, involving the U.S. Department of Energy, the **Ohio Coal Development Office**, **EPRI**, a consortium of boiler manufacturers, and the Oak Ridge National Laboratory, is in progress to identify, evaluate, and qualify the materials needed for tubing and piping in the construction of a coal-fired, ultra-supercritical steam power boiler.

Such a boiler will deliver steam to the high-pressure turbine at a temperature of at least 1350°F (732°C) and pressure at 5,000 psi (35 MPa), with at least one reheat at 1400°F (760°C) to the intermediate-pressure turbine. No steam turbine presently operates at such severe conditions.

As a result, a new project has been initiated to determine what materials developments are needed to ensure that steam turbines can be built for application in USC steam plants.

The specific targets are aligned with the destinations of the **DOE-CURC-EPRI Clean Coal Technology Roadmap**, of 677°C steam in the near-term (by 2010),

See Turbines on page 3

Interest Grows For Fibrils In Commercial Applications

ReMaxCo Technologies, a participant on the Advanced Research Materials Program, recently completed the first phase of a project to demonstrate the feasibility of microwave growth of silicon carbon fibrils.

The success of this first phase has captured the attention of industry.

Dick Nixdorf, President, reports that "several large–cap companies in the polymer fiber business have approached ReMaxCo with interest in spinning fibrils for high-temperature, high-strength commercial applications."

In addition, a commercial consortium, comprised of major players in the computer chip business, has asked ReMaxCo to consider using the fibril product for imparting certain enhanced properties to improving the capacity of printed circuit boards for computers.

The reaction vessel of the first phase was not capable of growing significant quantities of silicon carbide fibrils; however, new equipment, suitable for larger-quantity production, is being designed and will be tested in mid-

See Interest Grows on page 2

The Fossil Report is published quarterly by Paul T. Carlson, Oak Ridge National Laboratory Fossil Energy Program

UNITED WE STAND

Tom Schmidt Retires

On January 31, the ORNL Fossil Energy Program bid farewell to Tom Schmidt, Manager of the Oil and Gas Research Programs.

Tom was responsible for considerable growth in the oil and gas research areas of the Fossil Energy Program, drawing on his extensive background in the industry.

Tom earned his Ph.D. from the University of Tennessee in 1967. His research, done at Oak Ridge National Laboratory under the direction of Sheldon Datz of the Chemistry Division, involved the first molecular beam measurements of a chemical reaction that was not an alkali/halide reaction.

Tom Schmidt

That same year, he accepted a position with Phillips Petroleum Research and Development in Bartlesville, Oklahoma. During his 26 years with Phillips, he authored 11 patents and received an IR-100 award in 1979 for his invention of a Dual Molecular Beam Mass Spectrometer.

At Phillips, Tom managed programs in Thermodynamics and Engineering Data, Fuels and Lubricants, Crude Oil Properties, Fusion Energy, Solar Energy, Coal Liquefaction, Laboratory Safety, and Operation of the first Resource Conservation and Recovery Act (RCRA)-approved hazardous waste incinerator in the United States.

In 1993, Tom returned to ORNL as a program development manager in the areas of Petroleum, Hydrogen, and Energy Efficiency.

He represented ORNL in the Natural Gas and Oil Technology Partnership and helped in the development of a large number of new research projects for ORNL.

In the years ahead, Tom plans to complete the development of 105 acres of Tennessee land known as Lost Ridge Views. His plans also include construction of two fishing lakes and a house.

Interest Grows from page 1

2003.

In its role on the Fossil Energy Program, "ReMaxCo remains focused on high-temperature materials to address problems in high-efficiency, coal-fired steam plants," says Nixdorf.

Recent interest seems to suggest that ReMaxCo's consideration of volume production of fibrils could result in price reductions for the commercial textile fiber and the computer industry as well.

*For more information on this activity, please contact **Richard Nixdorf,** ReMaxCo technologies, Inc.*

*This work in sponsored by the **DOE Office of Fossil Energy**, **National Energy Technology Laboratory**.*

Argonne Continues Work On NDE For Thermal Barrier Coatings

As a part of the effort to improve reliability of thermal barrier coatings for advanced coal-gas fired turbines, Argonne National Laboratory researchers have recently completed a series of tests using their **patented elastic optical backscatter NDE method**.

These tests confirmed that the laser backscatter is sensitive to the condition of the interface below the TBC, which is a likely indicator of a pre-spall condition.

The work has been conducted in conjunction with the South Carolina Institute for Energy Studies (SCIES) Program at the University of Pittsburgh.

*For more information on this work, please contact **Bill Ellingson**, Argonne National Laboratory.*

Electronic Reporting Takes A Step Forward

Since it's inception, the Fossil Energy Advanced Research Materials Program, the anchor of the Materials Research and Development activities of the ORNL Fossil Energy Program, has required each subcontractor participant to document the research in topical and final reports.

Over the years, these reports have been published in paper form and distributed to select, but limited, distributions.

With the Web quickly becoming the primary medium for virtually all information gathering, the ARM Program has made a move to full electronic publishing of technical reports from subcontractors.

Henceforth, all such reports will be uploaded to the Fossil Energy Program Web site in Adobe Acrobat format and be configured to permit searching using the Adobe Acrobat search engine.

Subcontracting organizations will realize significant savings in time and expense with this new publishing pathway. Additionally, current research will be available to a virtually unlimited distribution in a more timely fashion.

Over the next several months, the Fossil Energy Program Web site will be extensively redesigned and will have direct links to all Advanced Research Materials Program reports published since October 2002.

It is hoped that this new approach will provide researchers around the world with ready access to the technologies being developed on the Fossil Energy Program.

And, your IN tray will be a lot less cluttered.

Turbines from page 1

and 760°C steam in the far-term (2020), as well as for future extensions to steam temperatures of 760-850°C.

The first phase of the project will assess recent developments worldwide in materials technology and steam turbine design to provide a basis for identifying critical materials needs and the major technical barriers.

Prioritization of the materials and manufacturing needs thus identified will be based on input from various stakeholders, and a work statement and implementation plan will be drawn up to address the CCT Roadmap needs.

Experimental work will draw heavily on basic understanding of alloy processing, microstructural evolution, and mechanical property changes with time and temperature, which will be applied to obvious candidates in specific alloy classes to provide insight into the possibilities of manipulation to extend the performance of current alloys, as well as the potential for and capabilities of significant alloy modification.

Data generated in all the phases of the program will be entered into a relational database that will be used to store, organize, and facilitate its retrieval and use. Close contacts will be maintained with the turbine manufacturers and the USC boiler project.

The project is led by Ian Wright and Phil Maziasz at ORNL, and Cindy Dogan at the **Albany Research Center**, and will include participants from other institutions who provide specific experience, expertise, and capabilities.

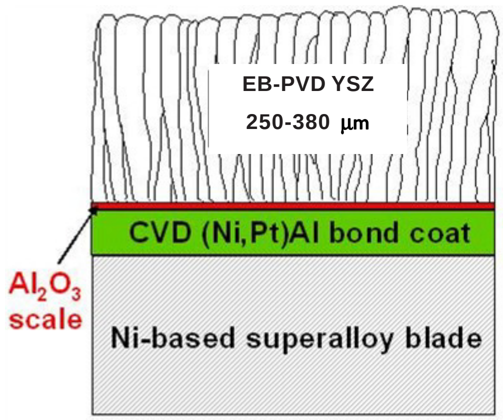
*For more information on this work, contact **Ian Wright**, Oak Ridge National Laboratory.*

*This work is sponsored by the **DOE Office of Fossil Energy**, **National Energy Technology Laboratory**.*

New Technique For Applying Thermal Barrier Coatings Under Development At ORNL

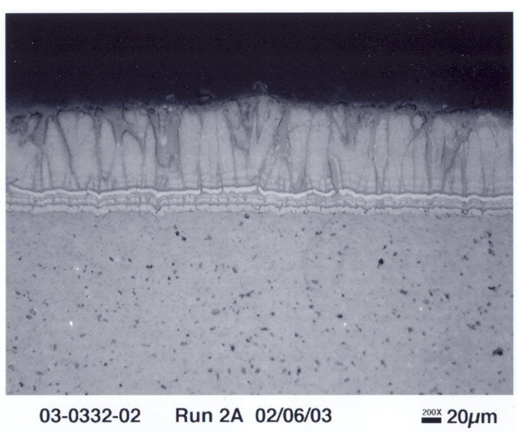
Thermal barrier coating systems are being increasingly applied to improve the performance, efficiency, and longevity of gas turbine engines. The thermal barrier is a ceramic layer, made of yttria-stabilized zirconia.

TBCs improve lifetimes by reducing the turbine blade temperature, in conjunction with internal blade cooling, enabling these components to operate in combustion gas streams at temperatures above the melting temperature of the blade alloy. The result is increased power and/or improved efficiency.



Typical TBC System

TBCs consist of an inner aluminum-rich bond coating that forms a protective alumina scale to protect the turbine blade from oxidation, and an outer, thermally-insulating YSZ top coating. The YSZ top coating is currently deposited onto the bond coating by electron beam, physical vapor deposition (EB-PVD) or by plasma spray techniques.



Optical image of a YSZ coating deposited on alumina (deposition time of 113 min)

Although EB-PVD TBCs typically have provided the best overall performance, the downside is that the EB-PVD process is very costly.

An alternative being developed at ORNL, under the direction of Ted Besmann, working with University of Louisville Professor Tom Starr and University of Florida graduate student Venu Varanasi, is metallorganic chemical vapor deposition, or MOCVD.

The MOCVD technique is potentially, significantly cheaper than EB-PVD, and the economics of a process is often what drives its ultimate commercialization and wide-scale use.

In fact, the goal of the present work at ORNL is to obtain the 250-380 μm-thick YSZ coatings, with a similar microstructure to that of EBPVD, but at a much lower cost.

Equally important, the technique can permit coating of surfaces which are unavailable to EB-PVD, since the latter is a line-of-sight process, and can also be used to produce a uniform seal-coating on an EB-PVD layer.

Recent results indicate that the use of MOCVD for the rapid deposition of columnar YSZ coatings is encouraging.

A columnar YSZ microstructure has been found to be desirable, in that it allows stress relief between the high-modulus, relatively low-thermal-expansion-coefficient ceramic coating and the alumina layer formed on the bond coating.

In fact, it is widely accepted that the ability of the current EB-PVD technique to produce a columnar microstructure is a major contributor to the long life of these coatings.

The current work at ORNL, according to Besmann, has the "potential to replace EB-PVD with the more efficient MOCVD technique, while preserving the desired microstructure, and has the unique potential of being able to coat hidden areas."

*For more information on this activity, contact **Ted Besmann** or **Ian Wright**, Oak Ridge National laboratory*

*This work in sponsored by the **DOE Office of Fossil Energy**, **National Energy Technology Laboratory**.*