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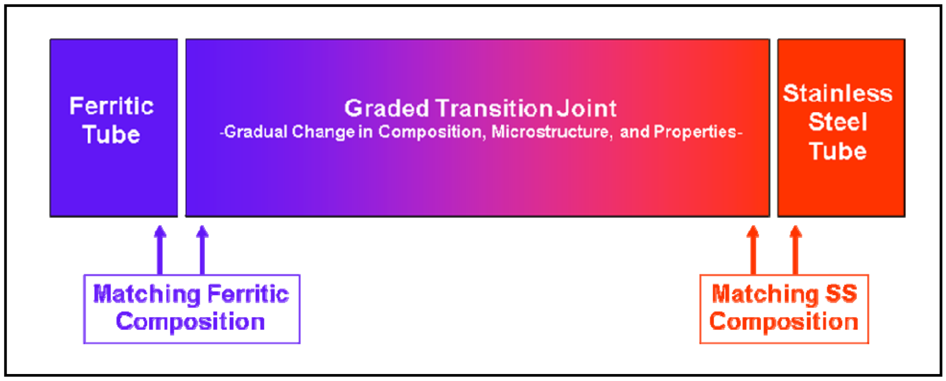
ERC ASSOCIATE DIRECTOR PARTICIPATING IN NEW MULTI-INSTITUTION WELDING RESEARCH PROGRAM

In an effort to increase conversion efficiencies of steam cycle power plants and reduce their carbon footprints, new materials are being developed in laboratories in the U.S., Europe and Asia for use in boilers, steam turbines and high pressure piping. While these alloys are intended to permit higher steam temperatures and pressures than have historically been used, poor weldability has proven to be a limiting factor in utilization of some of the new alloys for power plant components. John DuPont, Associate Director of the Energy Research Center and Professor of Materials Science and Engineering, is participating in a new multi-institution research program funded by the National Science Foundation and industry which promises to result in new improved alloys and new methodologies for assessing and improving material weldability.

DuPont explains, "Formed in September 2010, the new NSF program is addressing technical needs related to materials joining, not only in fossil energy, but also in nuclear energy, renewable energy, energy efficiency, and energy storage. These needs can be grouped under the following six broad categories: joining of existing materials, joining of new advanced materials, joining of dissimilar materials, manufacturing for hybrid materials, life extension of existing joints and rapid evaluation of life of weldments."

The mission of the program includes reduction of the time and cost of deploying advanced materials for the new energy infrastructure, life extension of material joints within the aging energy infrastructure, and training of engineering graduates with welding and joining background for employment within the energy field. A typical project includes topics such as advanced joining processes, innovative process control and automation, material development, weldability and characterization and integrated process modeling."



In a graded transition joint, the composition and properties of the joint are gradually changed to avoid the sharp transitions that lead to dissimilar weld failures. Two similar metal joints replace the failure-prone dissimilar joint.

DuPont adds, "The program operates in four universities (Lehigh University, The Ohio State University, Colorado School of Mines and University of Wisconsin) and collaborates with government laboratories such as Oak Ridge National Laboratory and Idaho National Laboratory and with sixteen energy companies. Each of the companies and government laboratories contributes $45,000 per year to participate in the program. Membership in the program allows organizations to develop a project specifically tailored for their needs and also provides access to all other projects supported through the program. Progress review meetings are held twice each year, and a website is being developed which will provide up-to-date progress on all the research. In addition, supporting members receive a significant reduction in the indirect cost rate of the research and receive matching funding from NSF. Graduate students assigned to these projects work closely with engineers and scientists at the member organizations in a team-based environment. Participating organizations have access to all the information generated by projects within the program and, thus, there is considerable leveraging of resources."

A total of seventeen projects are currently being conducted through the NSF program. For the first year, three projects, all with a focus on electric power generation, are being conducted by DuPont's team at Lehigh. These are:

- **Development of coextruded coatings for mitigating corrosion fatigue cracking in waterwalls.** Corrosion-fatigue cracking of waterwall weld overlay coatings is currently a serious problem in coal-fired plants. This project involves development of a new coating method for making waterwall coatings with improved resistance to corrosion-fatigue cracking. The research involves collaboration with a power company, a coating manufacturer, and Oak Ridge National Laboratory. Recent results have shown these new coatings have an appreciable improvement in performance over currently used weld overlay coatings. Large-scale production of full length waterwall tubes is currently in progress, and the tubes will be installed for field testing in the spring. Laboratory corrosion-fatigue testing of the new coatings is also in progress.

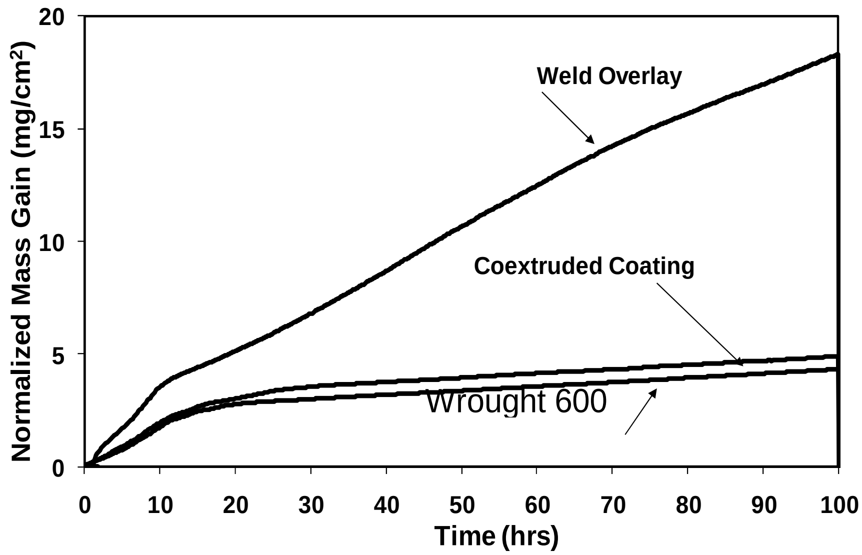
(Continued on Page 2)

("Welding Research" Continued from P. 1)

- **Design and fabrication of graded transition joints for avoiding dissimilar weld failures.** Dissimilar weld (DMW) failures continue to occur in existing plants, and the problem is expected to be even more severe in new nuclear and ultrasupercritical coal-fired plants that currently call for dissimilar metal welds in their designs. This program leverages a recently funded NSF project in which methods for designing and fabricating transition joints with improved performance have been developed. The transition joints are made with a gradual change in composition and properties, thus avoiding the sharp change in composition and properties of DMWs that leads to failure.
- **Investigation of the creep behavior of IN740 welds for supercritical power plants.** Alloy IN740 has been selected for new ultrasupercritical power plants due to its excellent creep properties. However, the welds in this alloy fail prematurely and require significant strength reduction factors. This could present a show stopper for use of this alloy, thus requiring a search for a new (yet unknown) material to meet the demanding needs of ultrasupercritical plants. The objective of this project, which is being carried out jointly with investigators from two companies and from Ohio State University, is to identify the causes of the reduced weld creep life and develop solutions to the problem, which may include development of a tailored filler metal.

Projects being conducted by other Universities in the NSF program with direct application to coal and nuclear power plants include:

- Filler Metals for Wide Gap Brazing of Turbine Components
- Robotic Gas Metal Arc Welding for Large Scale Structures
- Process Modifications to Tailor Weld Microstructure and Properties
- Development of Welding Consumables for Minimizing Residual Stresses in Welds
- Advanced High Strength Steels for Energy Efficiency
- Repair and Maintenance of Cr-Mo Grade Steels



Corrosion results of nickel alloy coatings prepared with the conventional weld overlay process and the new coextrusion process. Comparison is also made to a wrought nickel alloy of the same composition. The slope of the lines are an indication of corrosion rate. Note the improved performance of the coextruded coating. The similarity in corrosion performance of the wrought and coextruded coating indicates that the coating process has no adverse affect on the corrosion resistance of the alloy. In contrast, the relatively poor corrosion resistance of the weld overlay is attributed to the process used to make the coating.

- Precipitate and Property Evolution in Multi-pass Steel Welds
- Microstructure Control in the Heat Affected Zone of Nickel Alloys ■

RESEARCHERS' PROFILES

- ***John DuPont*** is Professor in the Materials Science & Engineering Department and Associate Director of the Energy Research Center. His research interests are in welding, corrosion, and alloy development.
- ***Edward Levy*** is Professor of Mechanical Engineering and Mechanics and Director of the Energy Research Center. His research deals with emissions control and performance improvement in coal-fired power plants.
- ***Nenad Sarunac*** is a Principal Research Scientist and Associate Director of the Energy Research Center. His research focuses on power plant heat rate improvement, emissions control and process optimization.