MSE SEMINAR

Materials Science and Engineering
Michigan Technological University

Tuesday, November 6, 2012
11:00 am – 12:00 pm
Room 610, M&M Building

Influence on Grain Size and Composition on the Creep-Rupture Behavior of Inconel Alloy 740

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Abstract

Advanced-Ultrasupercritical Power Plants with steam temperatures up to 760°C have the potential to reduce CO2 by 25% over today's current steam boiler technology through higher efficiency operation. To realize this technology, a new high-strength creep-resistant boiler alloy, INCONEL® 740, was developed. The alloy will operate for long-times and high stresses thus creep deformation and microstructural stability are key concerns. In this work, creep-rupture experiments were conducted on multiple heats of the nickel-based superalloy INCONEL® 740 at temperatures between 923 and 1123K (650 and 850°C). The interactions between chemistry, microstructure, and creep performance were evaluated by analysis of creep data, optical microscopy, electron microscopy, and computational thermodynamics. The data show that grain size has a modest effect on the creep-rupture strength. Computational thermodynamics verified experimental observations of the formation of eta phase as a function of temperature and alloy chemistry, but the kinetics for the precipitation of eta phase did not agree with the experimental findings. Despite the formation of eta phase and the concomitant reduction in volume fraction of gamma prime, the creep resistance of the alloy is insensitive, within the range of chemistries tested, to the volume fraction of gamma prime. The creep ductility was found to increase with test temperature. Precipitation of a large volume fraction of eta phase (greater than 7%) appears to reduce the creep-rupture ductility, but smaller amounts do not produce adverse effects.

Bio: Dr. John Shingledecker is a Senior Project Manager in the Materials & Chemistry research area of the Electric Power Research Institute (EPRI). He is the leader of EPRI's Program 87, Fossil Materials and Repair, which provides the power industry with material use and selection guidelines, welding and repair solutions, corrosion mitigation methodology, and remaining life tools to increase plant availability, reduce failures, and improve efficiency. Shingledecker has published more than 100 papers and reports, including 50 technical peer reviewed papers on the metallurgy and behavior of high-temperature engineering alloys. He is a technical leader for the U.S. Department of Energy (DOE)/Ohio Coal Development Office Advanced Ultrasupercritical (A-USC) Steam Boiler and Turbine Consortia.

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