

Design and Development of High-Temperature 9% Cr Steels for Power Plant Applications

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Abstract

Structural steels soften when heated above several hundred °C due to the transition from athermal dislocation glide to thermally activated glide and diffusion processes accelerating changes of the microstructure critical to strength. We utilize a combination of several strategies for the design of high-temperature 9% Cr steels: reduced carbon concentration to suppress Cr₂₃C₆, precipitating semi-coherent mono-carbonitride precipitates (MX, M=slow-diffusing early transition metal, X=carbon or nitrogen), minimizing the driving force and nucleation of Laves and Z-phases, for enhanced microstructural stability, and addition of Mo/W for solid solution strengthening. Our intended application is for steam generators in power plants. We will present and discuss results from computational and experimental studies, including TEM, high-temperature Vickers hardness and creep measurements as a function of exposure to 700°C.

Short Biography

Yip-Wah Chung is currently Professor of Materials Science and Engineering and Mechanical Engineering as well as co-Director of the Institute for Sustainability and Energy at Northwestern. He joined the University in 1977, serving as Director of the Center for Engineering Tribology at Northwestern from 1987 to 1992, Department Chair from 1992 to 1998, and program officer in surface engineering and materials design at the U.S. National Science Foundation from 2003 to 2005. He has published over 200 papers in surface science, thin films, tribology, and alloy design, two textbooks (*Practical Guide to Surface Science and Spectroscopy*, *Introduction to Materials Science and Engineering*), one monograph (*Micro- and Nanoscale Phenomena in Tribology*) and was the co-editor of a six-volume *Encyclopedia of Tribology*. Current research studies include thin films and coatings, tribology, high-performance steels, and advanced lubricants for improved vehicle efficiency. He was named Fellow, ASM International; Fellow, AVS; and Fellow, Society of Tribologists and Lubrication Engineers. He also holds several pilot and instructor certificates, including commercial multi-engine and remote pilot certificates.

