Rensselaer

LEADERS in ENGINEERING

"Corrosion and Hydrogen in Zirconium Alloy Fuel Cladding"

•

Wed., March 9, 2016

10:30 AM – 11:30 AM

DCC 330

Arthur T. Motta
Chair of Nuclear Engineering Program
Department of Mechanical and Nuclear Engineering
Penn State University

ABSTRACT: In face of increasing worldwide demand for electricity generation and the increasing concerns with the contribution of fossil fuel emissions to climate change, nuclear power is again being considered for further development in the US and abroad. New reactor construction is being proposed, using, both, evolutionary concepts based on the current fleet of Light Water reactors (LWRs) and advanced reactor concepts such as those proposed under the Generation IV initiative. The materials used in these reactors have to maintain outstanding performance for years or even decades, in an extreme environment, in which they are exposed to a combination of high temperature and pressures, aggressive chemistry and a constant fast neutron flux.

Uniform corrosion of zirconium alloy fuel cladding and the associated hydrogen pickup is a potential life-limiting degradation mechanism for nuclear fuel cladding in existing and advanced light water reactors, since hydrogen ingress can cause cladding embrittlement. It is of great interest to fuel vendors and utilities to limit cladding embrittlement, both by decreasing the overall corrosion and by decreasing the amount of hydrogen ingress for a given corrosion rate (the hydrogen pickup fraction), so mechanistic understanding of the effect of alloying elements on the process is essential. We present here experiments in synchrotron radiation, TEM, atom probe and cold neutron prompt gamma activation analysis in combination with theoretical understanding to attempt to clarify the role of alloying elements on corrosion and hydrogen pickup. It is of great interest also to determine the transport of hydrogen within the cladding and any inhomogeneities in hydrogen distribution in the form of hydride rims and blisters, which can severely affect fuel cladding properties such as strength, ductility and fracture toughness.

As utilities and fuel vendors attempt to push materials to higher temperatures and doses many challenges become apparent in all these areas. These concepts and challenges will be reviewed in this talk as well as the opportunities to new experimental tools and techniques to understand these processes in a more fundamental manner.

BIO: Arthur Motta is the Chair of the Nuclear Engineering Program and a Professor of Nuclear Engineering and Materials Science and Engineering at Penn State University. He holds degrees in Mechanical Engineering and Nuclear Engineering from the Federal University of Rio de Janeiro, Brazil, and a Ph.D. in Nuclear Engineering from the University of California, Berkeley. For the last twenty five years, Dr. Motta has worked in the area of radiation damage and environmental degradation to materials with specific emphasis in Zr alloys, with current projects in the areas of mechanical testing, corrosion and radiation damage. He has special interests in using advanced characterization techniques such as x-ray scattering from synchrotron radiation sources, transmission electron microscopy, and in situ irradiation to discern fundamental mechanisms of corrosion and radiation damage. He is a Fellow of the American Nuclear Society and has recently been awarded the ASTM William J. Kroll Medal for sustained impactful contributions to zirconium metallurgy including corrosion, hydriding, mechanical properties and irradiation effects.