Advanced Materials for Applications in Extreme Environments

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RADIATION DAMAGE TO CERAMIC AND INSULATING MATERIALS FOR NUCLEAR POWER

*Invited Paper

*Invited Paper

NANOSTRUCTURED MATERIALS IN HARSH ENVIRONMENTS

*Invited Paper

PREFACE

Symposium Q, "Structural Materials and Fuels for Future Fusion and Fission Technologies," Symposium R, "Radiation Damage to Ceramic and Insulating Materials for Nuclear Power," and Symposium T, "Nanostructured Materials in Harsh Environments," were held Nov. 29–Dec. 3 at the 2010 MRS Fall Meeting in Boston, Massachusetts. This volume includes papers based upon these symposia. The underlying theme behind the papers is that of materials for next-generation technologies, especially fusion and fission energy production and the nanoscale properties of these materials when subjected to high temperature and pressure. In many cases, joint experimental and modeling programs (to minimize expensive trial-and-error techniques) are underway to understand the fundamental processes that are at the basis of the materials. This combined approach is optimal to design novel new materials that can withstand the higher operating temperature, high radiation doses, and complex thermomechanical loading required in the next-generation nuclear systems. It is especially important to understand the role of defects and flaws in small volumes as their energetics and interactions elicit the observed mechanical response.

Accelerated use and integration of nanomaterials can be enabled by the complementary combination of atomistic and multiscale simulations with integrated *in situ* instrumentation and techniques in which synthesis, testing, environmental control, and direct imaging occur simultaneously.

The articles here investigate mainly nanomaterials, ferritic martensitic steels, oxide dispersed steels (ODS), and ceramic and insulating materials. Ceramic materials are important because many have good radiation tolerance properties, and recent results also indicate that small nanoparticulate inclusions of ceramics in the ODS materials can also help mitigate the bubble growth of inert gases produced by nuclear reactions, besides improving general mechanical properties.

Materials for nuclear energy is not the only area in which the study of nanosized objects is important. The investigation of the mechanical response of nano- and microscale components that comprise other next-generation technological devices (such as nanopillars, nanotubes, nanowires, nanolayers, ultrathin films, nanoparticles, and nanocrystalline and nanotwinned materials) must be investigated in the context of their unique microstructure and its evolution.

This volume, therefore, highlights some emerging topics in novel mechanical testing techniques, *in situ* microscopy, high- and low-temperature deformation mechanisms, radiation damage investigations, and mechanical property characterization of materials, as well as recent advances in atomistic and multiscale modeling.

Thak Sang Byun
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