

Actinides and Nuclear Energy Materials

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Actinides and Nuclear Energy Materials

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*Invited Paper

PREFACE

This proceedings volume contains papers presented at Symposium Y, “Actinides - Basic Science, Applications, and Technology” and Symposium S, “Design of Materials for Sustainable Nuclear Energy,” held in San Francisco, California, April 9–13, 2012 as part of the 2012 MRS Spring Meeting. Symposium Y was the sixth in a series held biannually at the Materials Research Society Meetings. The series gathered actinide researchers from around the globe to discuss current experimental, theoretical, and modeling work, and to generally address scientific and technological issues in the field. The high level of interest in these symposia reflects both the potential renaissance in actinide science due to the potential use of nuclear energy as a non-greenhouse-gas emitting fuel, and the concerns around the dangers posed by nuclear power plants, as well as the ongoing interest in the highly unusual electronic and magnetic states in actinide materials, e.g., the heavy fermion superconductors.

Symposium Y addressed fundamental research into actinide-based materials, which remains a frontier in condensed matter physics, chemistry, and biology, with the materials science demands and complications surrounding 5f orbitals forming some of the most complex research areas. Many of the materials issues were considered in synergy with Symposium S, which focused directly on the materials science needed to advance next-generation nuclear energy systems and to extend the life of existing systems, with particular emphasis on understanding the combination of radiation, elevated temperature, stress, and harsh chemicals encountered in nuclear applications, which place stringent demands on material performance.

This year’s Actinides symposium featured sessions in the core research areas of nuclear energy technology and materials, condensed matter physics, molecules, complexes and clusters, and other fundamental research into actinide chemistry and biology. The 98 presentations tackled the many unanswered questions revolving around actinide science, especially the role of f-electrons in bonding, their so called “dual nature” exhibiting both localized and delocalized behavior, and other fundamental chemistry concerns, especially those relating to surface effects, biological concerns, and the role of actinides in the environment.

The Sustainable Nuclear Energy Symposium S was also very well attended, with 51 talks and 22 posters covering a variety of topics from radiation effects on ceramic and metallic nuclear fuels and structural materials, to separation of actinides and fission products, all the way to the design and synthesis of innovative materials for the next generation reactors. The models and simulation techniques included atomistic calculations of defect formation and diffusion, meso-scale simulations of microstructural effects and continuum simulations of heat and chemical transport in reactor materials. Experimental studies of fuel and structural materials behavior in operation and storage provided information for model validation and materials design.

The papers in this volume highlight the major themes of the two symposia: actinide physics, actinide chemistry, actinide materials science, and applications of actinide materials to nuclear fuel cycles.

The organizers thank all the participants for their contributions to the two symposia. We also thank the staff at the Materials Research Society headquarters for their generous assistance in organizing the symposia. Finally, we thank Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Lawrence Berkeley National Laboratory for their financial support of Symposium Y.

Symposium Y

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