Overview

The Fourteenth International Symposium on Effects of Radiation on Materials was held on 27–30 June 1988 in Andover, MA. This biennial symposium series commenced in 1956 and has served as a major international forum for the exchange and discussion of both the fundamental and technological aspects of behavioral changes in materials exposed to radiation environments. The high level of participation at the latest symposium required four full days of conference sessions, and the peer-reviewed proceedings are being published in three volumes.

The papers from the first three days of the symposium appear in the two volumes of this ASTM Special Technical Publication (STP) 1046. Volume I encompasses radiation damage-induced microstructures; point defect, solute, and gas atom effects; atomic-level measurement techniques; and applications of theory. Volume II includes mechanical behavior, all papers dealing with pressure-vessel steels, breeder reactor components, dosimetry, and nuclear fuels. The fourth day of the symposium was devoted to the single topic of reduced-activation materials, including austenitic, ferritic, and vanadium alloys, for future fusion reactors; these papers are being published in a companion volume: ASTM STP 1047, *Reduced-Activation Materials for Fusion Reactors*.

The first two sections of Volume I, *Microstructures: Ferritics* and *Microstructures: Austenitics*, deal with the effects of radiation on the structures of alloys being developed for high-dose environments, such as the first wall of a fusion reactor. One notable theme is the profound influence of certain "minor" (that is, present in low concentration) but critical alloying elements, such as titanium, phosphorous, and others, primarily through the unique phases and microstructures they induce. Examples are offered of fine dispersions of precipitates acting as distributed point defect and gas atom traps with the result that the growth of large voids or bubbles is inhibited. Both neutron and charged-particle irradiations have been employed in these papers, while analytical transmission electron microscopy (TEM) seems to be the major technique of investigation.

In *Gas Effects*, a large number of papers (12) explore various aspects of what is probably the most pernicious nuclear transmutation product, helium. If it is not hindered from collecting in bubbles at grain boundaries, the frequent result is helium embrittlement, which becomes a principal constraining factor for operation at high irradiation temperatures. Among the papers presented are studies of helium embrittlement in ferritic alloys, in pure nickel and nickel-base alloys, a direct comparison between austenitic and martensitic steels, helium effects in the different regions of stainless steel welds, and bubble formation in pure copper and aluminum. There are also fundamental studies of bubble formation for various inert gas species, and a technique paper offering a new way to introduce helium in mixed-spectrum reactor experiments by the use of nickel-bearing foils adjacent to the specimens.

The section on *Radiation-Induced Segregation or Phase Changes* is an important one because such radiation-induced modifications threaten to undo some of the hard-won gains in resistance to radiation damage obtained from increasingly sophisticated alloying. An alloy matrix can be depleted of critical constituents, and if segregation or precipitation occurs at the grain boundaries, the material can be embrittled. These papers explore the extent of segregation of such elements as phosphorous, silicon, and nickel in mainly austenitic or ferritic alloys, typically with the aid of surface analytical tools, such as Auger electron spectroscopy or secondary ion mass spectrometry (SIMS). Included are two papers dealing with the amorphization under irradiation of precipitates in zirconium alloys.

The papers in the section on *Microstructural Modeling* reflect the fact that the theory used to model radiation effects has reached a high level of sophistication. These papers move beyond simple predictions of the dose or temperature dependence of void swelling to explore more fundamental defect behavior and the complex interactions between the various extended defects that are observed in irradiated materials. Topics include: the direct influence of sinks, such as dislocations, precipitates and bubbles, on void swelling; dislocation loop formation; the formation of void and loop lattices; and possible void-dislocation interactions that could lead to swelling saturation. Two papers that are of specific interest to the fusion materials community consider the influence of pulsed irradiation and the important problem of helium bubble formation at grain boundaries.

The five papers in the section on *Fundamental Defect Behavior* focus on the early stages of radiation damage. The techniques used in the work reported here include internal friction, SIMS, and heavy-ion irradiation in a high-voltage electron microscope. The materials ranged from austenitic alloys to the A15 superconductors. These results provide critical information about defect behavior and parameters that are required for modeling studies. The papers discuss the nature of the displacement cascade, the small defect clusters that are formed as the cascade collapses, and the fraction of the originally-created defects that survive and diffuse out of the cascade. It is primarily these latter defects that lead to the observable effects of radiation. The fate of these freely migrating defects and the helium that is produced by nuclear transmutation reactions is also discussed.

The last section in Volume I, *Special Measurement Techniques*, comprises a number of specialized applications using effects from the domain of physics as novel tools for the probing of atomic-level processes. The techniques employed are positron annihilation, internal friction, the Mossbauer effect, and nuclear gamma resonance.

Nicolas H. Packan
Oak Ridge National Laboratory, Oak Ridge, TN 37831; symposium chairman and coeditor.

Roger E. Stoller
Oak Ridge National Laboratory, Oak Ridge, TN 37831; symposium vice-chairman and coeditor.

Arvind S. Kumar
University of Missouri-Rolla, Rolla, MO 65401; symposium vice-chairman and coeditor.