5.0 REFRACTORY METALS AND ALLOYS *140*

No contributions

6.0 AUSTENITIC STAINLESS STEELS *141*

6.1 THE STRONG INFLUENCE OF DISPLACEMENT RATE ON VOID SWELLING IN VARIANTS OF FE-16CR-15NI-3MO AUSTENITIC STAINLESS STEEL IRRADIATED IN BN-350 AND BOR-60—N. I. Budylkin, E. G. Mironova, N. M. Mitrofanova, and V. M. Chernov (Bochvar Institute of Non-Organic Materials), S. I. Porollo (Institute of Physics and Power Engineering), T. M. Bulanova, V. K. Shamardin (Research Institute of Atomic Reactors), and F. A. Garner (Pacific Northwest National Laboratory) 142

Recent irradiation experiments conducted on a variety of austenitic stainless steels have shown that void swelling appears to be increased when the dpa rate is decreased, primarily by a shortening of the transient regime of swelling. This paper presents results derived from nominally similar irradiations conducted on six Russian steels, all laboratory heat variants of Fe-16Cr-15Ni-3Mo-Nb-B, with each irradiated in two fast reactors, BOR-60 and BN-350. The BN-350 irradiation proceeded at a dpa rate three times higher than that conducted in BOR-60. In all six steels, a significantly higher swelling level was attained in BOR-60, agreeing with the results of earlier studies.

6.2 INFLUENCE OF RADIATION-INDUCED VOIDS AND BUBBLES ON PHYSICAL PROPERTIES OF AUSTENITIC STRUCTURAL ALLOYS—E. N. Shcherbakov, A. V. Kozlov, and I. A. Portnykh (FSUE Institute of Nuclear Materials), Iouri I. Balachov (SRI International), and F. A. Garner (Pacific Northwest National Laboratory) 147

Void swelling in austenitic stainless steels induces significant changes in their electrical resistivity and elastic moduli, as demonstrated in this study using a Russian stainless steel irradiated as fuel pin cladding in BN-600. Precipitation induced by irradiation also causes second-order changes in these properties. When cavities are full of helium as expected under some fusion irradiation conditions, additional second-order changes are expected but they will be small enough to exclude from the analysis.

6.3 CHARACTERIZATION OF STRUCTURAL CONDITIONS OF AISI 316 ANALOG STAINLESS STEEL IRRADIATED IN THE BN-350 REACTOR—O. P. Maksimkin, K. V. Tsai, L. G. Turubarova, and T. Doronina (Institute of Nuclear Physics, Almaty, Kazakhstan), and F. A. Garner (Pacific Northwest National Laboratory) 153

In several recently published studies conducted on a Soviet analog of AISI 321 stainless steel irradiated in either fast reactors or light water reactors, it was shown that the void swelling phenomenon extended to temperatures as low as ~300°C, when produced by neutron irradiation at dpa rates in the range 10^{-7} to 10^{-8} dpa/sec. Other studies yielded similar results for AISI 316. In the current study a blanket duct assembly from BN-350, constructed from the Soviet analog of AISI 316, also exhibits swelling at dpa rates on the order of 10^{-8} dpa/sec, with voids seen as low as 281°C and only 1.3 dpa. It appears that low-temperature swelling at low dpa rates occurs in 300 series stainless steels in general, and during irradiations conducted in either fast or mixed spectrum reactors.

7.0 MHD INSULATORS, INSULATING CERAMICS, AND OPTICAL MATERIALS *160*

7.1 RECENT PROGRESS IN THE DEVELOPMENT OF ELECTRICALLY INSULATING COATINGS FOR A LIQUID LITHIUM BLANKET—B. A. Pint, P. F.Tortorelli (Oak Ridge National Laboratory, USA), A. Jankowski, J. Hayes (Lawrence Livermore National Laboratory, USA), T. Muroga, A. Suzuki (NIFS, Japan), O. I. Yeliseyeva (G. V. Karpenko Physico-Mechanical Institute NASU, Ukraine), and V. M. Chernov (Bochvar Institute of 161

Inorganic Materials, Russia)

There are very few candidate MHD coating materials since Li dissolves most oxides and many carbides and nitrides do not have sufficient electrical resistivity for this application. The past few years have seen great changes in the research emphasis and strategy for MHD coatings. Problems with CaO have led to a focus on new candidates with low cation solubility in Li, such as Y_2O_3 and Er_2O_3. Coatings of these materials are being fabricated by a variety of processing techniques and the resistivity and microstructure characterized. Progress is being made in the development of MHD coatings, but as yet no coatings have shown sufficient compatibility with Li. Electrical resistivity results from Y_2O_3 coatings as-deposited and after exposure to Li are presented. Self-healing and in-situ coatings are being investigated based on CaO from Li-Ca and Er_2O_3 from Li-Er. Anticipated problems with defects in ceramic coatings, either as-fabricated or due to tensile cracking, suggests that the most viable coating strategy will have to be multi-layered. An outer metallic layer will prevent Li from wetting cracks in the inner ceramic insulating layer and also limit interaction between the ceramic and Li. Whether the MHD coating is single- or dual-layered, processing issues will need to be addressed before the issue of compatibility can be answered.

8.0 BREEDING MATERIALS ***170***

No contributions

9.0 RADIATION EFFECTS, MECHANISTIC STUDIES, AND EXPERIMENTAL METHOD ***171***

9.1 THE EFFECTS OF INTERFACES ON RADIATION DAMAGE PRODUCTION IN LAYERED METAL COMPOSITES—H. L. Heinisch, F. Gao, and R. J. Kurtz (Pacific Northwest National Laboratory) **172**

Multilayered composites consisting of many alternating metal layers, each only nanometers thick, possess enormous strength, approaching theoretical limits. These materials also display unexpectedly high thermal and mechanical stability [1]. Their unique properties derive from the operation of deformation mechanisms that do not occur in conventional metallic materials and are a result of the large internal interfacial areas and high coherency strains of the nanolayered metals. The enormous interface area to volume ratio of these materials may also positively affect their resistance to radiation damage, making them potentially useful materials for applications in fusion reactors.

9.2 MULTISCALE MODELING OF RADIATION DAMAGE IN Fe-BASED ALLOYS IN THE FUSION ENVIRONMENT—B. D. Wirth (Department of Nuclear Engineering, University of California Berkeley), G. R. Odette (University of California, Santa Barbara), J. Marian (California Institute of Technology), L. Ventelon (University of California, Berkeley), J. A. Young and L. A. Zepeda-Ruiz (Lawrence Livermore National Laboratory) **179**

Extended Abstract

9.3 INFLUENCE OF PKA DIRECTION, FREE SURFACES, AND PRE-EXISTING DEFECTS ON CASCADE DAMAGE FORMATION—R. E. Stoller, S. G. Guiriec (Oak Ridge National Laboratory) **180**

Primary cascade damage production in iron has been extensively investigated by molecular dynamics, and average defect production parameters, such as the total number of stable point defects, in-cascade defect clustering fractions, and in-cascade cluster size distributions have been derived. However, preliminary results indicated several factors could alter “normal” cascade evolution and lead to quite different defect production behavior. Further investigations of three such factors have been carried out: (1) primary knock-on atom (PKA) direction, (2) nearby free surfaces, and (3) pre-existing effects.

Results of the investigation confirm these factors can significantly impact cascade damage formation. The effects include enhanced defect survival for PKA directions that lie in close-packed {110} planes, increased point defect clustering and larger defect clusters for cascades initiated near a surface, and reduced defect survival in simulation cells containing defects. The origin and implications of these effects are discussed relative to the interpretation of certain experimental observations and parameters used in other modeling studies.

9.4 DISLOCATION INTERACTIONS WITH VOIDS AND HELIUM BUBBLES IN FCC METALS—J. A. Young (Lawrence Livermore National Laboratory), B. D. Wirth (Department of Nuclear Engineering, University of California Berkeley), J. Robach, and I. M. Robertson (University of Illinois, Urbana-Champaign) **190**

Extended Abstract

9.5 THE EFFECTS OF GRAIN BOUNDARY STRUCTURE ON BINDING OF He IN Fe—R. J Kurtz and H. L. Heinisch, Jr. (Pacific Northwest National Laboratory) **191**

Extended Abstract

9.6 DISLOCATION-STACKING FAULT TETRAHEDRON INTERACTION: WHAT WE CAN LEARN FROM ATOMIC SCALE MODELING—Yu. N. Osetsky, R. E. Stoller, and Y. Matsukawa (Oak Ridge National Laboratory) **195**

Stacking fault tetrahedra (SFTs) are formed under irradiation of fcc metals and alloys with low stacking fault energy. The high number density of SFTs observed suggests that they should contribute to radiation-induced hardening, and, therefore, taken into account when estimating mechanical properties changes of irradiated materials. The central issue is describing the individual interaction between a moving dislocation and an SFT, which is characterized by a very fine size scale on the order of a few to one-hundred nanometers. This scale is amenable to both in-situ TEM experiments and large-scale atomic modeling. In this paper we present results of an atomistic simulation of dislocation-SFT interactions using molecular dynamics (MD). The MD simulations modeled an edge dislocation interacting with SFTs with different sizes and at different temperatures and strain rates. The results are compared with observations from in-situ deformation experiments in which several interactions between moving dislocations and SFTs were observed. It is demonstrated that in some cases the simulations and experimental observations are quite similar, suggesting a reasonable interpretation of experimental observations. Other cases, when modelling does not reproduce experimental observations, are also discussed and the importance of strain rate, dislocation nature and specimen surface effect are indicated.

9.7 KINETIC MONTE CARLO SIMULATIONS OF DISLOCATION DECORATION AND RAFT FORMATION IN BCC-IRON UNDER CASCADE IRRADIATION—M. Wen, N. M. Ghoniem (Department of Mechanical and Aerospace Engineering, University of California, Los Angeles), and B. N. Singh (Risø National Laboratory, Denmark) **201**

Under neutron irradiation, primary defect clusters of both self-interstitial atom (SIA) and vacancy type are directly produced in displacement cascades, which have been confirmed by experiments as well as molecular dynamics simulations. The highly mobile SIA clusters play a crucial role in the development of characteristic microstructures, such as rafts of SIA clusters and dislocation decoration, and the corresponding radiation hardening behavior [1]. We have developed a new approach to KMC simulations to investigate the segregation and accumulation of point defects at the atomic scale with incorporating the elastic interaction between defect clusters and microstructures by using the elastic representation of point defects due to Kröner [2]. The decoration of dislocations by SIA clusters and the formation of rafts in bcc-iron are modeled in detail, and the general