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Irradiations were performed on eighteen different experiments during this period. The joint research effort by U.S. and Japanese scientists who used the RTNS-II to test materials for future fusion reactors formally ended in March 1987. However, the last experiments at the RTNS-II Facility will end in late May, after which the Facility will be prepared for placement in storage. Over 450 experiments were performed during the five-year joint agreement involving 136 different researchers in 6 different countries.

1.2 Design and Fabrication of HFIR-MFE RE* Spectral Tailoring Irradiation Capsules (Oak Ridge National Laboratory and Midwest Technical, Inc.) 8

Design and fabrication of four HFIR-MFE-RB capsules (60, 200, 330, and 400°C) to accommodate specimens preirradiated in spectrally tailored experiments in the ORR are proceeding satisfactorily. The capsule designs are being standardized as much as possible and the fabrication drawings are being prepared on a computer-aided design (CAD) system to minimize overall long-term costs. Preparation of fabrication drawings for the capsule containment tube parts and 330°C capsule internal parts hes been completed, and fabrication of some parts has started. Fabrication drawings for the 60°C capsule are scheduled to be completed by May 1987, and for the 400 and 200°C capsules by August 1987. Operation of the 330 and 60°C capsules is scheduled to begin in April 1988, and the other two (400 and 200°C) in October 1989.*

A conventional temperature control gas gap between the test specimen holder and containment tube, although relatively small, was selected for the 330°C capsule design. Development efforts are in progress to test a larger particle-filled gap concept for possible use for temperature control in the 200°C capsule. In this concept, temperature would be controlled primarily by varying the inert gas pressure in an annular bed of coarselfine microspheres to change its thermal conductance.

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The thermal analysis was completed with the conclusion that the heat generation rate axial profile should be modified to match the JP DPA curve profile to reflect the steeper gradient observed outside the 300-mm centered about the horizontal midplane (HMP).

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A summary of materials in the Fusion Program Research Materials Inventory indicates the nominal diameter of rod or thickness of sheet for product forms of each alloy and also indicates by weight the amount of each alloy in larger sizes available for fabrication to produce other product forms as needed by the program. No material was added to the inventory during this reporting period.

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Data are also presented to show the influence of silicon and phosphorus on the neutron-induced swelling of Fe-25Ni-15Cr and to demonstrate that the separate influence of each of these elements is more complex than previously observed. Similar complex trends have also been seen in ion bombardment experiments but there are additional distortions relative to the neutron-induced behavior that arise from the interaction of these elements with point defect gradients.

A model is presented to show that the major effect of composition on swelling lies in its influence on void nucleation, operating primarily on the intermediate transition regime. Compostional variations thus is due to the effect of each element on the vacancy supersaturation via their effect on either the equilibrium vacancy concentration or the effective vacancy diffusion coefficient.

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6.2.1 The Development of Austenitic Stainless Steels for Fast Induced-Radioactivity Decay (Oak Ridge National Laboratory) 177

As part of an alloy-development program for a nickel-free stsinless steel, five Fe-Mn, thirteen Fe-Cr-Mn, and fifteen Fe-Cr-Mn-C alloys were examined to determine the austenite-stable region in the Fe-Cr-Mn-C system. After various heat treatments, optical and electron microscopy studies and magnetic measurements were used to assess the microstructural constituents present. The results indicate that the Schaeffler diagram, which was developed to predict the phases present in Fe-Cr-Ni-C stainless steels, cannot be directly applied to Fe-Cr-Mn-C steels. Manganese has a lower austenite-stabilizing capability against δ-ferrite formation then the Schaeffler diagram predicts by simply considering it half as effective as nickel. However, its stabilizing capability against martensite formation is higher than predicted by the diagram on the same basis. The new results can be used to empirically establish the austenite-stable composition region that should be suitable for alloying to develop a manganese-stabilized stainless steel.

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6.2.3 Irradiation-Produced Precipitates in Austenitic Stainless Steels Irradiated in HFIR to 36 dpa at 600°C (Japan Atomic Energy Research Institute, assigned to Oak Ridge National Laboratory) 209

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Impact tests have been completed on unirradiated one-third size Charpy specimens of V-15Cr-5Ti. The ductile-to-brittle transition temperature was unexpectedly high, on the order of 130°C. Irradiation of this alloy in FFTF-MOTA in lithium-filled TZM subcapsules has also been completed at 385, 420, 520, and 600°C, with damage levels ranging from 10 to 30 dpa. Impact tests on these specimens are now being planned.

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In addition, this effort provides for correlation of complementary fabrication work on V-12Cr-5Ti and V-10Cr-10Ti alloys at Teledyne Wah Chang Albany.

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No contributions received this period

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6.5.2 Thermal Convection Loop Studies in Support of Mass Transport Modeling of Lithium/12Cr-1MoVW Steel Systems (University of California – Los Angeles and Oak Ridge National Laboratory) 281

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6.5.3 Thermal Gradient Mass Transfer in Ferrous Alloy Pb-17 at. % Li Systems (Oak Ridge National Laboratory) 285

Scanning electron microscopy and sssociated energy dispersive x-ray analysis of type 316 stainless and 12Cr-1MoVW steels exposed to thermally convective Pb-17 at, % Li yielded quantitative information about changes in surface morphology and

composition as a result of mass transfer reactions. In the case of type 316 stainless steel, substantial preferential dissolution of nickel and chromium occurred at 500°C and led to the formation of a deep corrosion zone of irregular penetration. The extent and morphology of this corrosion zone was found to be sensitive to the starting microstructure of the steel. The 12Cr-1MoVW steel corroded uniformly with no change in its surface concentration. Mass transfer deposits in the type 316 stainless steel system differed depending on their position in the cold leg, where the temperature varied from 400 to 460°C. Depending on the temperature, the majority of the deposits were principally composed of iron, iron-nickel, or chromium.

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7.3 Solid Breeder Materials Fabrication and Mechanical Properties (Argonne National Laboratory) 304

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8. CERAMICS 305

No contributions received this period.

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An integrated approach has been developed for rapid screening of the influence of component variables on the performance of electrical insulators required for superconducting magnets in magnetic fusion energy systems. It incorporates an efficient method for specimen production in the form of 3.2-mm (0,125-in) diameter rods. Test methods include short-beam shear, fracture strength (G_{Ic}), and strain-controlled torsion. Unreinforced (neat resin) and glass-fiber reinforced specimens having three types of epoxy matrices and one type of bismaleimide matrix have been produced and submitted to ORNL for irradiation in the LTNIF facility. However, the irradiation was not performed during the present reporting period due to startup delays on the LTNIF facility. Furthermore, NBS has been informed by ORNL personnel that the required irradiation cannot be performed on the type € glass-reinforced specimens due to the interaction between the high thermal neutron flux in the reactor and the boron element in this type of glass.