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The first data on the effect of fast reactor irradiation on the impact behavior of 2½Cr-1Mo steel were obtained. Third-size specimens were irradiated in FFTF to ~10 dpa at 365°C. An increase in DBTT of 170°C was observed, similar to the shift observed for 12Cr-1MoVW steel following comparable irradiation. The reduction in the upper-shelf energy for the 2½Cr-1Mo steel was less than that observed for 12Cr-1MoVW steel. Because of the low DBTT of unirradiated 2½Cr-1Mo steel, the DBTT after irradiation remained below that for 12Cr-1MoVW steel.

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- 6.2.3 NEUTRON-INDUCED SWELLING OF MODEL Fe-Cr-Mn-NI ALLOYS AND COMMERCIAL MANGANESE-STABILIZED STEELS — (Pacific Northwest Laboratory, Westinghouse Hanford Company, and Hokkaido University) 211

The addition of nickel to both simple and solute-modified Fe-Cr-Mn alloys leads initially to an increase in neutron-induced swelling. The addition of various minor solutes, particularly silicon, in general leads to a reduction in swelling. Depending on composition, thermomechanical condition and irradiation temperature, a wide variety of swelling behavior is observed in various commercial Fe-Cr-Mn alloys. There is some indication in the commercial alloys of massive formation of ferrite phases during irradiation at 420°C, leading to a reduction in the swelling rate.

- 6.2.4 THE DEVELOPMENT OF AUSTENITIC STAINLESS STEELS FOR FAST INDUCED-RADIOACTIVITY DECAY -- (Oak Ridge National Laboratory) 217

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The tensile and fatigue properties of cold-worked copper and a commercial Cu-Al₂O₃ dispersion-strengthened alloy were measured at temperatures between 25 and 600°C. The GLIDCOP Al-15 alloy, which contains 0.15 wt % Al in the form of Al₂O₃ particles, exhibited a significantly higher tensile and fatigue strength than copper under all test conditions. The mechanical properties of this alloy appear to be suitable for high-strength, high-conductivity alloy applications in fusion reactors.

6.4.2 UNUSUAL TENSILE AND FRACTURE BEHAVIOR OF PURE COPPER AT HIGH LEVELS OF NEUTRON-INDUCED SWELLING — (University of Illinois and Pacific Northwest Laboratory) 243

The most common measures of ductility are uniform and total elongation and reduction of area. Pure copper in the unirradiated state exhibits large amounts of both measures of ductility along with a serpentine glide fracture morphology. After irradiation at 411-414°C with fast neutrons to 34 or 50 displacements per atom (dpa), the tensile and fracture behavior change greatly. Significant uniform elongation is retained but the reduction of area is very small.

Such a unilateral shift between macroscopic measures of ductility is unusual. The fracture surface is also unusual and reflects not only the influence of the large swelling levels attained during irradiation but also the distribution of swelling near grain boundaries. The unique fracture mode in highly voided copper appears to enhance susceptibility to crack propagation and sudden failure without necking, even though the material exhibits a significant level of uniform elongation prior to failure.

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6.5.1 COMPATIBILITY BETWEEN VANADIUM-BASE ALLOYS AND FLOWING LITHIUM: PARTITIONING OF HYDROGEN AT ELEVATED TEMPERATURES — (Argonne National Laboratory) 257

Hydrogen fractionation occurs between lithium and various refractory metals according to a temperature-dependent distribution coefficient, K_H , that is defined as the ratio of the hydrogen concentration in the metallic specimen to that in the liquid lithium. In the present work, K_H was determined for pure vanadium and several binary (V-10Cr, V-15Cr, V-5Ti, V-15Ti, V-20Ti, V-30Ti) and ternary alloys (V-10Cr-5Ti, V-15Cr-1Ti, V-15Cr-5Ti, V-3Ti-0.5Si), and the commercial Vanstar 7 (V-10Cr-3Fe-1Zr). Hydrogen distribution studies were performed in an austenitic steel forced-circulation lithium loop. Equilibrium concentrations of hydrogen in vanadium-base alloys exposed to flowing lithium at temperatures of 350 to 550°C were measured by inert gas fusion techniques and residual gas analysis. Thermodynamic calculations are consistent with the effect of chromium and titanium in the alloys on the resultant hydrogen fractionation. Experimental and calculated results indicate that K_H values are very low; i.e., the hydrogen concentrations in the lithium-equilibrated vanadium-base alloy specimens are about two orders of magnitude lower than those in the lithium. Because of this low distribution coefficient, embrittlement of vanadium alloys by hydrogen in lithium would not be expected.

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The degree of sensitization of 25% cold-worked PCA irradiated at 60, 200, 330, and 400°C up to 7 dpa under spectrally tailored conditions in the ORR-MFE-6J/7J experiments was evaluated by the electrochemical potentiokinetic reactivation (EPR) test technique on miniaturized TEM disk-type specimens. Irradiation at 60°C to 7 dpa did not affect the reactivation behavior of PCA. The reactivation charge of PCA was increased by the irradiation at 200, 330, and 400°C, as compared with unirradiated Control specimens, and increased with increasing irradiation temperature. Post-EPR examination of the specimen surfaces showed grain boundary etching for the specimen irradiated at 400°C, but not for the specimens irradiated at 330°C and below. This indicates that the intergranular stress corrosion cracking (IGSCC) susceptibility associated with chromium depletion along grain boundaries was not increased by the irradiation at temperatures below 330°C to this damage level. Localized attack across the grain faces was observed for all the specimens irradiated at 200, 330, and 400°C, which suggests the Occurrence of localized sensitization in the grain interior. The investigation of the possibility of the localized sensitization in grain interiors and its effects on the corrosion behavior is in progress.

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The FUBR-1B irradiation experiment in EBR-II has provided important information on the irradiation behavior of candidate lithium solid breeder materials in a high energy neutron Spectrum. The solid breeder materials include Li₂O, LiAlO₂, Li₂ZrO₃, Li₂ZrO₆, and Li₆SiO₆ pallets and LiAlO₂ spheres. The irradiation behavior of the materials was characterized for the temperature range from 400 to 900°C. The amount of tritium retained by the solid breeder materials, as well as swelling and physical stability, was determined for specimens removed after the first period of irradiation.

LiAlO₂, Li₂ZrO₃, and Li₂ZrO₆ exhibited excellent dimensional stability during irradiation while the dimensional stability of Li₂O was found to be dependent on the microstructure. The amount of retained tritium is compared to similar closed capsule experiments and extends the data to burnups as high as 1.6 x 10²¹ at/cc.

7.2	DESORPTION CHARACTERISTICS OF THE LiAlO ₂ -H ₂ -H ₂ O (g) SYSTEM — (Argonne National Laboratory)	286
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Temperature programmed desorption (TPD) measurements have started on the LiAlO₂-H₂ system. The sensitivity of the mass spectrometer that will detect the peaks was shown to be adequate for the measurements. Blank experiments to characterize the behavior of the stainless steel sample tube in the measurements have revealed the evolution of N from the steel, a process facilitated by H₂. It is necessary to stabilize the sample tube so that it does not augment or distort the TPD peaks. The behavior of an unstabilized tube was demonstrated by means of a simulated TPD run. Stabilization consists of treating the tube with 990 ppm H₂ in helium at high temperature until undistorted simulated TPD runs are obtained. A LiAlO₂ sample was loaded in the apparatus: it came from the same batch of material that was used in an EXOTIC test. Prolonged drying of the sample in a He-H₂ stream is necessary, a finding that has important implications for many earlier reports on measurements of tritium release from irradiated samples where it was not demonstrated that the sample was adequately dry or that the apparatus did not affect the data.

8.	CERAMICS	291
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8.1	HELIUM-ASSISTED CAVITY FORPATION IN ION-IRRADIATED CERAMICS — (Oak Ridge National Laboratory and Nagoya University, Nagoya, Japan)	293
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Polycrystalline specimens of spinel (MgAl₂O₄) and alumina (Al₂O₃) were irradiated at room temperature and 650°C with either dual- or triple-ion beams in order to investigate the effects of simultaneous displacement damage and helium implantation on cavity formation. The cavities in alumina were aligned along the direction of the c-axis, with diameters ranging from <2 to 10 nm. The cavities in spinel were preferentially associated with dislocation loops and were of similar size as the cavities in alumina. Catastrophic amounts of Cavitation were observed at the grain boundaries in spinel when the displacement damage level exceeded a critical value (~20 dpa) in the presence of a fusion-relevant (~60 appm/dpa) helium environment.

8.2	IN SITU MEASUREMENTS OF DIELECTRIC PROPERTIES IN ALUMINA -- (Oak Ridge National Laboratory)	297
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A series of experiments have been planned to measure the dielectric properties of alumina in the presence of ionizing and displacive irradiation.

8.3	CERAMICS FOR FUSION PROGRAM RESEARCH PATERIALS INVENTORY — (Oak Ridge National Laboratory)	299
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A stock of commercial, polycrystalline alumina with four different levels of purity (0.94, 0.976, 0.995, and 0.998) has been added to the Fusion Reactor Materials inventory. The material is in the form of 3/4 in. (0.998) and 1 in. (0.94) diameter rods and 2 in. by 2 in. bars (0.976 and 0.995).