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Damage Analysis and Fundamental Studies

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The structure of the DAFS Task Croup has been modified to improve program implementation and to increase emphasis on mechanical behavior.

Several U. S. laboratories will participate in an international exercise, termed REAL-80, to study uncertainties in integral parameters (such as dpa) deduced from spectrum unfolding.

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Machine reliability is good and improving. One lot of targets was found to delaminate in service, causing a temporary target shortage.

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New measurements have been made of the production of ^{7}Be from ^{7}Li and on the activation of copper by 10-35 MeV deuterons.

The cross section processing code NJOY is operable on the HEDL UNIVAC; it will be converted from the CDC 7600 to the CRAY-1 at the NMFECC at Livermore.

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An FMIT Neutron Activation Library (to 40 MeV) has been established.

CHAPTER 3. ENVIRONMENTAL CHARACTERIZATION 21

1. Flux Gradients and He Calculations for ORR-MFE 1 (ANL) 23

Preliminary flux gradients are given for the MFE 1 experiment; they agree reasonably well with new neutronics calculations. Helium measurements are compared to calculations. Dosimetry capsules have been completed for the MFE 4 experiment to start in early 1980.

2. Helium Accumulation Fluence Dosimetry for the MFE-1 Irradiation at ORR (RIES) 30

Helium analyses were completed for a matrix of pure-element helium accumulation neutron dosimeters irradiated in the Oak Ridge Research Reactor MFE-1 experiment. The results provide both ORR dosimetry information and helium production information relevant to candidate fusion reactor materials. A set of dosimetry materials was prepared for the first MFE-4 experiment.

3. Flux-Spectral Measurements at the IPNS Spallation Source (ANL) 36

Neutron and proton flux-spectral measurements have been completed ,for tantalum and uranium mock-up targets for the Intense Pulsed Neutron Source (IPNS) now under construction at Argonne. The uranium target produces about 50% more neutrons/500 MeV proton than the tantalum target.

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CHAPTER 4. DAMAGE PRODUCTION 41

1. Damage Analysis Studies of Insulators (BNL) 43

Gamma-ray flux spectra produced in iron by a *Li(d,n) source, as calculated* from *two versions* of *MORSE, are significantly different.*

The status is *given of efforts to evnluate ionization-assisted displacement cross sections.*

2. Modeling of Defect Production in High Energy Cascades (HEDL) 49

Raising the displacement energy in MARLOWE in order to make the simulation of high energy cascades feasible has only a small effect on annealed cascades. The calibration of *the annealing code SCAS is described.*

CHAPTER 5. DAMAGE NICROSTRUCTURE EVOLUTION AND MECHANICAL BEHAVIOR 61

1. Review of Needs for Developing Fission-Fusion Correlations (HEDL) 64

The status of radiation effects data on 316 SS and their interpretation is discussed briefly *in light of the need for projections to the ETF environment.*

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2. The Effect of Solute Additions on Void Nucleation (HEDL) 71

in 316 stainless steel, nickel and silicon are major determinants of the swelling behavior. While the role of silicon can be ascribed at least partially to the fast-diffusion effect, the role of nickel cannot, and its influence lies in the operation of other physical mechanisms.

3A. Simultaneous Irradiation Experiments in Controlled Oxygen Atmospheres (W-R&D) 88

Very rapid swelling in dual ion bombarded 316 SS is shown to be independent of the ambient oxygen partial pressure.

3B. Rapid Cavity Growth in Simultaneously Bombarded 316 SS at 600°C (W-R&D) 91

Atomic displacement and helium injection rate mapping of the rapid cavity growth regime is shown to be possible over 2-3 orders of magnitude variation in rates.

3C. Experimental Determination Of The Maximum Equilibrium Bubble Size In 316 SS and Comparison With The Theoretically Predicted Critical Cavity Size For The Transition From Gas-Driven To Bias-Driven Growth (W-R&D) 93

Experimentally determined maximum equilibrium bubble sizes and "upper bound" theoretical critical cavity sizes for a transition from gas-driven bubble growth to bias-driven void growth are shown to be in reasonable agreement.

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4. Heavy Ion Irradiation of Copper Alloys (U. Wisconsin) 100

Irradiation of Cu-0.5 w/o Be with 14 MeV Cu ions to 4-40 dpa at 350-475°C reveals copious precipitation and Be enrichment near the irradiated surfaee. Lesser enrichment is found in an unirradiated region. No Co enrichment was found in a Cu-1 w/o Co specimen.

5. High Energy Neutron Studies (B-PNL) 106

Tensile specimens of Ti, V, and oxygen-doped Nb have been prepared for irradiation in RTNS-II.

6. RTNS-II Irradiation Program (HEDL) 113

The dosimetry from the HEDL-2 irradiation shows a maximum fluence of 1.19 x 10^{18} n/cm^2 and a spatial variation that is consistent with a beam diameter of about 1 em. The high vacuum furnace designed and fabricated at HEDL has been received and assembled at RTNS-II.

7A. Creep Deformation Behavior of Type 316 Stainless Steel (ANL) 118

Negative irradiation creep observed in solution annealed and aged type 316 stainless steel is shown to be limited to a small dose, ~0.2 dpa. Electron irradiation of the alloy suggests the formation of ferrite via radiation induced segregation as a possible mechanism.

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7B. **Radiation-Induced Segregation and Irradiation Creep** (ANL) **120**

Radiation-induced segregation of Si to point defect clusters is shown to be the cause of irradiation hardening observed in Ni-4% Si alloy. Ni-12.8% Al alloy shows very little irradiation enhancement of creep, und no irradiation hardening

8. An **Experimental Investigation Into Some Parameters and Fracture Criteria Used** In **Recent Helium Embrittlement Theories** (U.**Virginia**) **131.**

No correlation was found between the areal helium bubble density and the grain boundary coverage in unirradiatcd SA 316 SS and neutron irradiated 304 SS, nor between the fracture surface dimple size/density and the interior bubble size/density. Other data indicate that the nature of the fracture is not determined by the amount of helium present.

9. HVEM *in-Situ* **Deformation of Neutron Irradiated** Fe-0.3 **a/o Cu (HEDL)** 148

Irradiation of Fe-0.3 Cu results in 1) a decrease in the size of the plastic zone ahead of a propagating crack, and 2) a crenulated dislocation structure resulting from obstacles to dislocation motion.