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Alloy Development for Irradiation Performance

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CONTENTS

Disks of EA (in several pretreatment conditions) and several heats of cold-worked (CW) type 316 and D9 type austenitic stainless steels have been irradiated in HFIR at 300, 504, and 600°C to fluences producing about 10 to 44 ?pa and 450 to 3600 at. ppm He. These samptes are being reirradiated in the Materials Open Test Assembly (MOTA) in FFTF at 500 and 600°C, together (side by side) with previously unirradiated disks of exactly the same materials, to greater than 100 dpa. These samples, many of which have either very fine helium cluster or helium bubble distributions after HFIR irradiation, are intended to test the possibility and magnitude of a helium-induced extension of the initial low-swelling transient regime relative to the void swelling behavior normally found during FFTF irradiation. Further, these samples will reveal the microstructural stability or evolution differences that correlate with such helium effects.

Specimens of the Path A EA and of N-lot 316 have been irradiated in HFIR at 400 to 600°C to fluences producing approximately 10 to 44 dpa and 500 to 3600 at. ppm He, in both the solution annealed and 20 to 25% cold-worked conditions. The cavity swelling and total microstructural evolution of most samples have been observed via transmission electron microscopy on identical disks irradiated side by side in HFIR, and immersion densities have also been measured prior to insertion into FFTF/MOTA (Materials Open Test Assembly of the Fast Flux Test Facility). These disks are currently being irradiated in the FFTF/MOTA !cycles 5 and 6), side by side with disks of the same material which were not previously irradiated in HFIR. These specimens have been divided into two subsets for discharges after 30 and 60 dpa.

Three miniature sheet-type tensile specimens and a miniature rod-type specimen are being used to determine irradiated tensile properties for alloy development .for fusion reactors. The tensile properties of type 316 stainless steel were determined with these different specimens, and the results were compared. Reasonably good agreement was observed. However, there were differences that led to recommendations on which specimens are preferred.

The eight capsules which constitute phase I of the U.S./Japan collaboration on HFIR irradiations have been inserted in HFIR on schedule.

Vanadium specimens of V-15Cr-5Ti, VANSTAR-7, V-3Ti-1Si, and V-20Ti are being irradiated in the FFTF-MOTA experiment. Miniature sheet tensile specimens and transmission electron microscopy (TEM) disks were preimplanted with ^{3}He to levels up to 480 at. ppm using the tritium trick and encapsulated in TZM capsules containing ^{7}Li. The specimens will be irradiated to damage levels up to 165 dpa with irradiation temperatures of 420, 520, and 600°C. All of the capsules at 600°C underwent a temperature excursion during their initial cycle and had to be replaced.

The assembly of all eight capsules, HFIR JP-1 through JP-8, has been completed, and they are now being irradiated. The parts fabrication assembly and flow testing of the prototype ORR capsules for 60°C and 200°C MFE6-J were completed and the capsule was inserted in the ORR. Performance was satisfactory in all respects.