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unsuccessful until now. In this study, analysis by transmission electron microscopy (TEM) was conducted on unalloyed V, V-5Ti, V-3Ti-1Si, and V-4Cr-4Ti specimens that were irradiated at <430°C in conventional and dynamic helium charging experiments. By means of dark-field imaging and selected-area-diffraction analysis, the characteristic precipitates were identified to be (V,Ti_{1-x}) (C,O,N). In V-3Ti-1Si, precipitation of (V,Ti_{1-x}) (C,O,N) was negligible at <430°C, and as a result, dislocation channeling did not occur and work-hardening capability was high.

In the absence of increases in oxygen concentration, additions of up to 400 ppm hydrogen to V-4 Cr-4 did not result in significant embrittlement as determined by room temperature tensile tests. However, when hydrogen approached 700 ppm after exposure at 325°C, rapid embrittlement occurred. In this latter case, hydride formation is the presumed embrittlement cause. When oxygen was added during or prior to hydrogen exposure, synergistic effects led to significant embrittlement by 100 ppm oxygen.

A systematic study has been initiated at Argonne National Laboratory to evaluate the performance of several V-Cr-Ti alloys after exposure to environments containing hydrogen at various partial pressures. The goal is to correlate the chemistry of the exposure environment with hydrogen uptake in the samples and its influence on the microstructure and tensile properties of the alloys. At present, the principal effort has focused on the V-4Cr-4Ti alloy of heat identified as BL-71; however other alloys (V-5Cr-5Ti alloy of heats BL-63, and T87, plus V-4Cr-4Ti alloy from General Atomics) are also being evaluated. Other variables of interest are the effect of initial grain size on hydrogen uptake and tensile properties, and the synergistic effects of oxygen and hydrogen on the tensile behavior of the alloys. Experiments conducted on specimens of various V-Cr-Ti alloys exposed to pH_2 levels of 0.01 and 3×10^{-6} torr showed negligible effect of H_2 on either maximum engineering stress or uniform and total elongation. However, uniform and total elongation decreased substantially when the alloys were exposed to 1.0 torr H_2 pressure. Preliminary data from sequential exposures of the materials to low-pO_2 and several low-pH_2 environments did not reveal an adverse effect on the maximum engineering stress or on uniform and total elongation. Further, tests in H_2 environments on specimens annealed at different temperatures showed that grain-size variation by a factor of ≈2 had little or no effect on tensile properties.

A test program is in progress at Argonne National Laboratory to evaluate the effect of pO_2 in the exposure environment on oxygen uptake, scaling kinetics, and scale microstructure in V-Cr-Ti alloys. The data indicate that the oxidation process follows parabolic kinetics in all of the environments used in the present study. From the weight change data, parabolic rate constants were evaluated as a function of temperature and exposure environment. The temperature dependence of the parabolic rate constants was described by an Arrhenium relationship. Activation energy for the oxidation process was fairly constant in the oxygen pressure range of

different samples to evaluate differences in the characteristics of various weldments. Several weldments were used to fabricate specimens for four-point bend tests. Several additional weldments were made with a YaG laser; here, the emphasis was on determining the optimal weld parameters to achieve deep penetration in the welds. A preliminary assessment was then made of the weldments on the basis of microstructure, hardness profiles, and defects.

The key thermophysical and mechanical properties for SiC/SiC composites are summarized, including temperature-dependent tensile properties, elastic constants, thermal conductivity, thermal expansion, and specific heat. The effects of neutron irradiation on the thermal conductivity and dimensional stability (volumetric swelling, creep) of SiC is discussed. The estimated lower and upper temperatures limits for structural applications in high power density fusion applications are 400 and 1000°C due to thermal conductivity degradation and void swelling considerations, respectively. Further data are needed to more accurately determine these estimated temperature limits.

Many methods for joining monolithic and composite silicon carbide are available. Three techniques are candidates for use in fusion energy systems: in-situ displacement reactions, pre-ceramic polymer adhesives, and reaction bonding. None of the methods are currently developed enough to satisfy all of the criteria required, i.e., low temperature fabrication, high strength, and radiation stability.

A short introduction with references establishes the current status of research and development of SiC_f/SiC composites for fusion energy systems with respect to several key issues. The SiC fiber and composite specimen types selected for the JUPITER 14J irradiation experiment are presented together with the rationale for their selection.

This paper provides the first known observation of silicon carbide fully amorphized under neutron irradiation. Both high purity single crystal hcp and high purity, highly faulted (cubic) chemically vapor deposited (CVD) SiC were irradiated at approximately 60°C to a total fast neutron fluence of 2.6×10^{25} n/m^2. Amorphization was seen in both materials, as evidenced by TEM, electron diffraction, and x-ray diffraction techniques. Physical properties for the amorphized single crystal material are reported including large changes in density (-10.8%), elastic modulus as measured using a nanoindentation technique (-45%), hardness as measured by

Disk specimens of ferritic-martensitic steel, HT9 and F82H, irradiated to damage levels of ~3 dpa at irradiation temperatures of either ~90°C or ~250°C have been investigated by using transmission electron microscopy. Before irradiation, tempered HT9 contained only $M_{23}C_6$ carbide. Irradiation at 90°C and 250°C induced a dislocation loop density of 1×10^{22} m^{-3} and 8×10^{21} m^{-3}, respectively. In the HT9 irradiated at 250°C, a radiation-induced phase, tentatively identified as α', was observed with a number density of less than 1×10^{22} m^{-3}. Difference in the radiation-induced phase and the loop microstructure may be related to differences in the post-yield deformation behavior of the two steels.

This collaborative study was initiated to determine mechanical properties at elevated temperatures of various copper alloys by University of Illinois and Pacific Northwestern National Lab with support of OMG Americas, Inc., and Brush Wellman, Inc. This report includes current experimental results on notch tensile tests and pre-cracked bend bar tests on these materials at room temperature, 200 and 300°C. The elevated temperature tests were performed in vacuum and indicate a decrease in fracture resistance with increasing temperature, as seen in previous investigations. While the causes for the decreases in fracture resistance are still not clear, the current results indicate that environmental effects are likely less important in the process than formerly assumed.

Extended Abstract.

Electrical conductivity and tensile properties have been measured on an extruded and annealed CuCrNb dispersion strengthened copper alloy which has been developed for demanding aerospace high heat flux applications. The properties of this alloy are somewhat inferior to GlidCop dispersion strengthened copper and prime-aged CuCrZr over the temperature range of 20-500°C. However, if the property degradation in CuCrZr due to joining operations and the anisotropic properties of GlidCop in the short transverse direction are taken into consideration, CuCrNb may be a suitable alternative material for high heat flux structural applications in fusion energy devices. The electrical conductivity and tensile properties of CuCrZr that was solution annealed and then simultaneously aged and diffusion bonded are also summarized. A severe reduction in tensile elongation is