EFFECT OF HIGH DOSE NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES AND STRUCTURE OF COPPER ALLOYS AND CU/SS JOINTS FOR ITER APPLICATIONS – S. A. Fabritsiev (D.V. Efremov Scientific Research Institute), A. S. Pokrovsky (Scientific Research Institute of Atomic Reactors), D. J. Edwards (Pacific Northwest National Laboratory), S. J. Zinkle, and A. F. Rowcliffe (Oak Ridge National Laboratory)

Extended Abstract (the full paper will be published in the Journal of Nuclear Materials as Proceedings of the Ninth International Conference on Fusion Reactor Materials, October 10-15, 1999, Colorado Springs, Colorado).

The base copper alloys Cu-Cr-Zr IG and GlidCopAl25 IG and Cu/SS joints manufactured in RF, US, EU, JA with the HIP method were irradiated up to 2 dpa at 200°C in SM-2 reactor. Tensile tests, shear tests, metallography and SEM investigations were performed. In general, the trends in radiation hardening and embrittlement were observed also at higher irradiation doses.

Hardening and embrittlement were found to be essentially the same in copper alloys of different types, i.e. PH - Cu-Cr-Zr and ODS - GlidCopAl25. The joints of GlidCopAl25/316 and Cu-Cr-Zr/316 type had high strength characteristics and satisfactory ductilities after irradiation.

The irradiated joints of GlidCopAl25/316 type demonstrated a high level of strength properties (σ_u ~350 MPa). Still, their σ_u is lower by about 100 MPa than for the irradiated base alloy GlidCopAl25 IG. It was shown that the lower ultimate strength of joints is partly determined by the lower σ_u of GlidCopAl25 alloy in the Z direction.

Cu-Cr-Zr/316 joints demonstrated strength properties at a level of the irradiated Cu-Cr-Zr (HIP) alloy σ_u ~260 MPa and a high ductility δ_{tot}~13%. It is apparently associated, first of all, with a higher capacity of the base alloy Cu-Cr-Zr for local deformation, when irradiated, than in the GlidCopAl25 alloy.

It should be noted that the last generation of joints demonstrated an essentially higher level of strength properties as compared with the first generation despite a ten times higher irradiation dose. The fact that none of the new joints (EU, JA, RF) demonstrated brittle fracture at low ~ 150 to 200 MPa stresses, as happened with the first generation of joints [6] reflects substantial progress in the technology of joint fabrication.