MECHANICAL CHARACTERIZATION AND MODELING OF BRAZED JOINTS OF REFRACTORY ALLOYS

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Within the scope of the European fusion power plant study for development of a concept for a He-cooled divertor, a transition joint between tungsten-based alloys and oxide dispersion-strengthened ferritic steels has been considered. In order to comply with the environmental conditions of the application, the usage of refractory alloys (W-1%La_2O_3 and EUROFER 97) is required. However joints of dissimilar materials suffer from a mismatch in coefficients of thermal expansion. The components of the joint are exposed to mechanical and cyclic thermal loads which give rise to development of high stresses and could possibly lead to fatigue and creep of the materials.

A mechanical characterization and modeling of a joint of refractory alloys is carried out. Preferable joining technique is high-temperature brazing at 1120-1180°C with Ni-based amorphous foils and brazing pastes as filler material. A temperature range between RT to 700°C is defined as operating condition for the materials. A set of finite-element computations has been performed to investigate the joint behavior and characterize it under that combined loading. The analyses are divided into steps to include the residual stresses in the joint as well as to consider the changing thermal load due to operating mode. The calculated stress distribution after a certain amount of load steps at different temperature levels considers different failure modes.

In order to verify the calculated data and provide a deeper understanding of the failure modes observed, mechanical characterization experiments, including tensile, shear, and isothermal fatigue, in the temperature range of RT-650°C are carried out at the Institute for Materials Research II, Forschungszentrum Karlsruhe, Germany.