Electron Beam Welding of Reduced Activation Ferritic Martensitic ODS-EUROFER Steel for Application in Helium Cooled Modular Divertor Concepts (P4-I-530)

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For specific blanket and divertor applications in future fusion power reactors a replacement of presently considered Reduced Activation Ferritic Martensitic (RAFM) steels as structural material by suitable oxide dispersion strengthened (ODS) ferritic martensitic or ferritic steels would allow a substantial increase of the operating temperature from ~550°C to about 650°C. In all cases appropriate joining technologies have to be developed. Diffusion welding techniques to perform similar and dissimilar joints have been studied successfully. Friction Stir Welding (FSW) has shown a good potential but application is limited due to geometrical restrictions and needs further development.

For the advanced helium-cooled modular divertor concept various joining techniques are required for joining the complex structural parts made of different materials. First attempts have been made for joining the divertor structures of ODS EUROFER by means of the Electron beam welding process with its highly concentrated energy input. This welding is widely used to produce high quality-high integrity welded similar and dissimilar joints of a large variety of materials.

For this purpose, samples of ODS-EUROFER steel were welded using a PTR 150 kV/15kW EB welding facility. Two different post-weld heat treatments (PWHT) were applied to investigate their influence on the mechanical and microstructural properties of the welded joints. Miniaturised tensile specimens were used to determine the tensile behaviour in the temperature range between RT and 700°C. KLST specimens were used for Charpy impact tests.

The microstructure of the weld and heat affected zone was examined using optical and scanning electron microscopy. Transmission electron microscopical methods were applied to investigate the size and spatial distribution of the dispersed oxides and potential segregation phenomena.