EUROFER improvement by optimized chemical compositions

J. Hoffmann*, M. Rieth, M. Klimenkov, S. Baumgärtner

Karlsruhe Institute of Technology, Karlsruhe, 76021 Germany

9%-Cr reduced activation steels are the designated structural materials for future fusion reactors. The improvement of this class of alloys, especially the extension of the operation limits, is the present scope of the EUROfusion materials project for advanced steels. Within this programme, new alloys are designed and fabricated to overcome some of the limitations of EUROFER97.

In the present study, three 9%-Cr alloys with some variations in the chemical compositions are compared to standard EUROFER97 batches. The main focus lies in the possible extension of the operation window to both higher and lower temperatures. The limits of the mechanical properties, which can be achieved through different heat and thermo-mechanical treatments are explored within this work. Toughness from Charpy impact tests, creep to rupture lifetime and tensile strength are compared for the different treatments. SEM investigations of the formed microstructures complete the presented work.

Strong effects of the heat-treatments on the toughness and strength were observed. As expected, hardening the materials beyond the conventional treatment (980°C/30min + 750°C/2h) showed a major increase in tensile strength and decrease in toughness. Moderate variations in the alloy compositions open the possibility for extended temperature windows for these unconventional heat treatments (e.g. higher tempering temperature). Thermo-mechanical treatments showed the predicted effect on hardening and other properties. As expected, the different heat treatments also showed the well-known effects on the mechanical properties (e.g. hardness and strength). However, the total effect of the heat treatments on the mechanical properties is far beyond the influence of minor changes in the alloy compositions.

*Presenting Author's e-mail: j.hoffmann@kit.edu

*Presenting Author's e-mail: j.hoffmann@kit.edu