Abstract

SANS investigation of precipitate evolution and optimum tempering temperature of RAFM nuclear reactor steel and weld

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Reduced Activation Ferritic/Martensitic (RAFM) steels, such as EUROFER, RUSFER, and China Low Activation Martensitic (CLAM), have been developed by the fusion materials community as structural materials for fusion reactor applications. These steels are optimized for low neutron activation and superior mechanical properties. Developed from Fe-Cr-Mo steels, RAFM steels replace high-activation elements such as Mo, Nb, and Co with W and Ta to minimize residual radioactivity after irradiation. In this study, the evolution of precipitates in RAFM steels is investigated using Small-Angle Neutron Scattering (SANS) on both in-situ thermally aged and pre-aged samples. SANS measurements enable the quantification of precipitate characteristics, including number density, volume fraction, and radius, across different regions such as the weld, heat-affected zone (HAZ), and base material. These insights provide a deeper understanding of the mechanisms governing strengthening and creep resistance at the microstructural level, establishing correlations with mechanical properties. The findings contribute to the ongoing development of RAFM steels for fusion reactor applications, with the identified optimal processing parameters offering valuable guidance for future advancements in nuclear structural materials.