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M2Or2A-02: Electromagnetic properties of austenitic stainless steels in cryogenic, high magnetic field environments

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Commonwealth Fusion Systems (CFS) is developing a high-field, compact tokamak, SPARC, enabled by REBCO-based high temperature superconducting (HTS) magnets. For the toroidal field magnetic coils, the REBCO tape is housed in austenitic stainless steel radial plates. The structural loads on the radial plates from Lorentz forces are extremely high during operation. Austenitic stainless steels are chosen for their high strength and low magnetization in SPARC operating conditions. Under extreme temperature and magnetic field, changes in electromagnetic properties can be profound if not accounted for when modeling the electric and magnetic performance of these components in cryogenic electromagnetic systems. While stress-induced martensitic transformation in austenitic stainless steels is well studied, the combined effects of cryogenic temperatures (<25 K), high magnetic field (>10 T), and mechanical stress alter the transformation kinetics. This research explores the effects of cryogenic temperature and high magnetic field cycling on key electromagnetic properties of the radial plate material. In this study, we have correlated electromagnetic properties at room temperature with in-situ measurements. We attribute the differences in room temperature electromagnetic properties and performance to potential phase transformations and dislocation build up in the material. The correlative models we have built from this data will be presented.

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