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M3Or4B-03: [Invited] Cryogenic Performance of Superconducting Magnet Structural Materials in SPARC

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The SPARC tokamak requires large, strong, and tough cryogenic structures to enable its high-temperature superconducting magnets. Stresses induced in these structures scales linearly with magnetic field, driving the selection of a high strength (Sy>900MPa) and high toughness (KIC>200MPa*m1/2) austenitic stainless steel. A custom composition of 316LN(H) has been chosen as the primary structural material for these magnets due to its favorable properties and ability to be produced commercially in large formats. CFS has produced and characterized an array of 316LN(H) forgings and plate products. Multiple 15+ ton forgings and thick gauge plates have been produced across multiple suppliers with moderate strength and high toughness at cryogenic temperatures, enabling the development of a property dataset used in component design. Additionally, CFS has developed a welding process using a manganese modified base chemistry of 18Cr-16Ni-5Mo-0.16N filler metal coupled with a GTAW or GMAW process which demonstrates high strength and moderate toughness. While 316LN(H) static properties have been reliably characterized, cryogenic fatigue properties are an open area that lacks a robust data set required for high fidelity component design. CFS's work in fatigue property development and the challenges in scaling steel structures for grid-scale fusion will also be addressed.

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