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M2Or1A-01: [Invited] High - strength austenitic stainless steels for fusion and accelerator magnet systems

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The ITER project is the largest international scientific collaboration aimed at developing fusion energy as a sustainable and clean source of energy. Its magnet system provides the magnetic confinement necessary for fusion reactions to occur and be sustained for long periods of time. The Large Hadron Collider (LHC) is the largest particle accelerator ever built. It consists of a 27 km ring of superconducting magnets and radiofrequency (RF) accelerating cavities. In both cases, High-strength structural materials play a crucial role in ensuring the integrity of the superconducting magnet system operated at cryogenic conditions.
The physical and mechanical properties of high-strength austenitic stainless steels and their importance for the structural integrity of the ITER magnet system are discussed. The rationale for the choice of multi-directionally redundant forged FXM-19 (also known as Nitronic 50) as the primary material for several structural components is explored, to cope with the stringent design requirements. The challenges faced in the steelmaking and processing of the material are also discussed.
Results issued from cryogenic tests on FXM-19 are presented, showing how the unique properties of this grade at cryogenic temperature, namely its high strength, excellent ductility, and high fracture toughness, make it an ideal material for the demanding requirements of the ITER magnet system.
This work shows how the selection of high-strength stainless steels is essential to ensure the safe and reliable operation of high-field superconducting magnets and illustrates how the continued development and optimization of these materials will be critical for the advancement of fusion energy technology but also accelerator magnets.

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