Contribution ID: **327** Contribution code: **TUE-PO1-615-02** Type: **Poster**

Evaluation of mass production results of cryogenic structural stainless steels for ITER toroidal field coil

Tuesday 16 November 2021 13:15 (20 minutes)

High tensile strength and fracture toughness at 4 K are required on structural materials for ITER Toroidal Field Coil (TFC) cases to withstand huge electromagnetic forces generated on TFC. However, hence there were no standard materials satisfying ITER requirements, QST developed new cryogenic structural material of JJ1 (0.03C-12Cr-12Ni-10Mn-5Mo-0.24N), and optimized nitrogen contents of 316LN to strengthen tensile strengths according to ITER requirements through trials since 1980s. These trial results served the basis to develop the material section of "Codes for Fusion Facilities -Rules on Superconducting Magnet Structure (2008)"issued by the Japan Society of Mechanical Engineers in October 2008 (JSME code). One of unique points of JSME code is that satisfaction of tensile test result at room temperature also guarantee results at 4 K. This JSME code was basis on material specification for ITER TFC cases'materials, and material manufacturing started from 2012. Totally over 2000 materials (over 5000 tons) have been manufactured by 6 fabricators and it was completed successfully in 2020. Material properties, e.g. chemical composition, grain size, tensile test at room temperature, Charpy impact test at 77K, were obtained as quality control test for all materials. In addition, around 600 tensile tests at 4K and 77K were performed as sampling test to confirm cryogenic tensile properties by QST. Those material properties and mechanical test results were stored in data base established by QST and correlation between mechanical properties and material properties were evaluated to optimize material specification for future superconducting magnets. This paper will show summary and evaluation results of the material properties of mass production for ITER TFC cases.

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Session Classification: TUE-PO1-615 Structural Materials for Magnets