The International Thermonuclear Experimental Reactor (ITER) project is a worldwide research experiment that aims to explore nuclear fusion as a viable source of energy for the coming years. The TF coils are constructed using Nb$_3$Sn CICCs due to the requirement of high magnetic field. The 316LN stainless steel material has been chosen as the TF jacket, due to its good mechanical properties at elevated temperatures, its excellent corrosion resistance and fabricability.

In order to reflect the true mechanical performance of the jacket material at 4.2 K preferably and to evaluate its suitability as ITER TF jacket, tensile tests on the full-size TF conductor jacket tubes were carried out at 4.2 K, 77K and 300 K. The 4.2 K test results present 28.8% for EL, 1100MPa for 0.2% YS and 1490 MPa for ultimate tensile strength, which are over the ITER requirements. Indeed, the full-size tubes failed not only along the slip band but also across the slip band. In this paper, we give thorough tests of the full size tube after tensile test, and provide a possible mechanism underlying the stress-strain and free energy linking to structure transformation and reveal a profound connection between the grain morphology changes and phase deformation.

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