Autopsy of an ITER TF Conductor Without Tcs Degradation Reveals Filament Fractures and Strand Movement

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Abstract— Prototype ITER Toroidal Field (TF) and Central Solenoid (CS) Cable in Conduit Conductors (CICCs) samples have been tested in the SULTAN facility under conditions that simulate ITER plasma operations, and they have shown a wide variety of degradation profiles. We have performed metallographic analyses on fully tested SULTAN samples to understand the physical changes that occur inside the cable during the electromagnetic cycling and warm-up cool-down (WUCD) cycles applied during the SULTAN tests. From the CS conductor autopsies, we learned that if transverse strand movement is blocked, there are no filament fractures and the current sharing temperature, Tcs, does not exhibit degradation vs. cycling in SULTAN. But among all the ITER TF conductors, there was only one prototype that did not exhibit Tcs degradation in SULTAN, and the metallographic autopsy of this sample revealed that significant transverse strand migration had occurred as well as fracture of some Nb3Sn filaments. The behavior of ITER CICCs cannot be fully understood unless the remarkable properties of this cable can be explained. In this paper we compare this cable with other TF as well as CS CICCs in an attempt to provide such an explanation.