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Influence of indentations on the critical current of Nb3Sn strands

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Japan Atomic Energy Agency is procuring all of theNb3Sn cable-in-conduit conductors for ITER Central Solenoid (CS). The CS conductor cable consists of 576 Nb3Sn strands of which diameter are 0.83 mm, 288 Cu strands, a central spiral and stainless steel wraps around the cable. The current sharing temperature (Tcs) of CS conductors with normal-twist-pitch cables degraded with electromagnetic (EM) cycles. On the other hand, the Tcs of short-twist-pitch (STP) conductors were stable under EM cycles because of the improvement in the bending property of STP cables. However, the short twist pitch increases the pressure between two strands at contact points, and strands become indented before the heat treatment for the reaction of Nb3Sn. Therefore, the influence of indentations on the critical current (Ic) of Nb3Sn strands need to be investigated. Ic measurements were carried out for indented bronze-route (BR) and internal-tin (IT) Nb3Sn strands. The strands were pressed and artificially indented across the longitudinal direction of the strands by an edge with a radius of 0.5 mm before the heat treatment. Then, the indented strands were wound onto ITER barrels of Ti6Al4V. The Ic were measured at 4.2 K and 12 T. When Ic decreased 5 %, the depths of the indentations were 0.26 mm and 0.37 mm for the BR and IT strands, respectively. These depths are defined as the critical indentation depths (dc). The Ic of both strand types decreased drastically with depth over dc. The degradation of Ic were probably caused by damage of the Nb filaments due to indentations. In order to maximize the superconducting properties of the Nb3Sn cable, the depth of indentation should be smaller than dc in the cable.

Primary author: Mr SUWA, Tomone (Japan Atomic Enrgy Agency)

Co-authors: Mr TSUTSUMI, Fumiaki (Japan Atomic Enrgy Agency); Mr MIYASHITA, Katsumi (SH Copper Products Co.,Ltd.); Mr SHIBUTANI, Kazuyuki (Japan Atomic Enrgy Agency); Dr SOUN PIL, Kwon (National Fusion Research Institute); Mr OSHIKIRI, Masayuki (Japan Atomic Enrgy Agency); Mr KI-HONG, Sim (Kiswire Advanced Technology Ltd.); Dr NUNOYA, Yoshihiko (Japan Atomic Enrgy Agency); Dr NABARA, Yoshihiro (Japan Atomic Enrgy Agency); Dr TAKAHASHI, Yoshikazu (Japan Atomic Enrgy Agency); Mr MURAKAMI, Yukinobu (Japan Superconductor Technology, Inc.)

Presenter: Mr SUWA, Tomone (Japan Atomic Enrgy Agency)

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