Improvement of the Critical Current upon Strain Cycling for an Internal Tin Processed Nb_3Sn Strand with Prolonged Heat Treatment

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Heat treatment dependence of the critical current at 4.2 K for an internal tin processed Nb_3Sn strand has been measured using a modified Walter spiral probe with which compressive or tensile strain can be applied reversibly to a strand solder on the outskirt of the spiral. For a Nb_3Sn stand heat treated at 650 °C for 100 hours, the *E-J* characteristics are well described by a typical empirical expression $E=J^n$, and the strain dependence of the critical current are in agreement with Ekin's strain scaling law. Upon strain cycling up to 100 times within reversible strain range, no degradation in the critical current is observed. However, for a Nb_3Sn stand heat treated at 650 °C for 200 hours, several step-wise jumps in voltage are measured and the *E-J* characteristics are irreversible if the voltage is measured with decreasing current, especially under tensile strain. The irreversibility is observed reproducibly and the step-wise feature in the *E-J* characteristic strongly depends on the applied field and strain. Interestingly, the critical current measured with compressive strain gradually increases upon strain cycling and after strain cycling more than 15 times, the compressive applied strain does not degrade the critical current. The reasons for the improvement of the critical current upon cycling for the prolonged heat treatment sample are further discussed in relation to the microstructural analysis results using FE-SEM before and after strain cycling.