§24. Local Strain and its Influence on Mechanical - Electromagnetic Properties of Nb_3Sn and Nb_3Al Strands

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In order to design the upgraded thermal fusion reactor, FFHR, the superconducting conductor and coil shall be used as indispensable key components. In practice, those superconducting devices will be exposed under a huge magnetic force field. Therefore it is important to investigate their mechanical and electromagnetic properties and to establish their diagnostic technology. With respect to this subject, some typical results in this fiscal year are reported here.

Practical superconducting wires like Nb_3Sn and Nb_3Al strands and other HTS tapes subjected for fusion reactors are typical composite material consisting of brittle superconducting component, oxide and metallic materials. Thermally induced strain generates in the composite inevitably due to different coefficient of thermal expansion and different elastic modulus among constituent components. It is necessary to evaluate its influences on both superconducting and mechanical properties. We have carried out the systematic investigation to measure thermal strain and lattice one in several practical superconducting wires quantitatively by means of quantum beam techniques. The thermal strains along both parallel and transverse to the strand are theoretically evaluated by the analytical manner. From comparison of calculated results with the observed values, the comprehensive calculation method has been established for Nb_3Sn and Nb_3Al strands and other HTS tapes.

Figure 1 shows the cross section of practical SC strands. In case of Nb_3Sn strand, Nb_3Sn filaments are embedded in the Bronze matrix and surrounded by the Nb barrier and stabilized Cu components. In the Nb_3Al strand fabricated by Jerry roll method, Nb_3Al filaments are embedded in the Cu matrix. Figure 2 shows the applied strain dependence of local strain exerted on the SC filaments along the axial and transverse directions. At the zero applied strain, the observed values give thermal strain. The thermal strain for Nb_3Sn strand is larger than that for Nb_3Al, while the lattice strain is similar for both strands. The lattice strain is defined as the increasing strain as a function of applied strain. The thermal strains along the axial and transverse direction of strand have been theoretically evaluated. The observed values were consistent with the calculated ones [1]. Further, the local strain exerted on the SC layer was investigated for the REBCO coated conductors [2, 3].

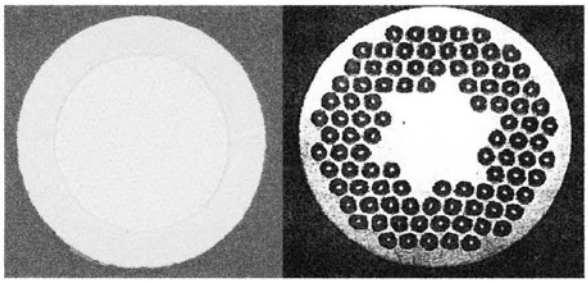
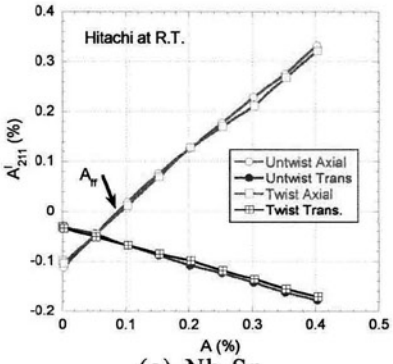
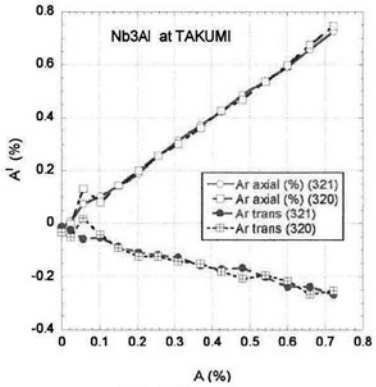


Fig. 1 Cross section of practical SC strands, (left) Nb_3Sn and (right) Nb_3Al.



(a) Nb_3Sn



(b) Nb_3Al

Fig. 2 Applied strain dependence of total local strain exerted on SC filaments.

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