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Switching processes in 2G HTS tape under magnetic field and short current pulses

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This report presents the results of studying switching processes in HTS tapes under pulsed loads. Investigation was performed on pulses of various amplitudes from 0.9 to 5 values of the critical current at a constant current. The minimum rise time of the front is 800 ns, the pulse width is from 1 to 200 μs. The current pulses were combined with a magnetic field parallel to the wide side of the HTS tape. Stable current flow on amplitudes up to 4 times the critical current without degradation of the superconductor is shown, as well as the influence of the magnetic field on the stability of the characteristics during pulse current switching. Regimes of transition instability and current oscillations at a constant pulse load were founded. A model for describing the observed features is proposed.
HTS tapes from three manufacturers were investigated: AmericanSuperconductor, SuperPower, SuperOx. The current - voltage characteristics of the samples were preliminarily measured and the critical currents of superconductors at a direct current were determined.
A pulsed current source and an automated experimental test bench were designed and manufactured for the study. The measurements were carried out by the four-contact method, the amplitude of the current was determined by the voltage on a calibrated shunt.
The measurements were carried out in liquid nitrogen. Two series of measurements were performed: with a characteristic time of current rise up to 3 ms (long pulses) and up to 1.5 μs (short pulses). On long pulses, a significant effect of thermal processes in the superconductor and metal layers of the tape on the switching process, arising of thermal instabilities and degradation of the HTSC ribbon was found. On short pulses there is no such effect. This is primarily due to the fact that the hot spot does not have time to develop and does not lead to an increase in the temperature of the superconductor above 3 degrees from the boiling point of nitrogen and the boiling crisis does not develop.
Based on the model of dynamic resistance in the flow regime, a qualitative explanation of the results was given. The velocity of motion of the vortices during short pulses and the coupling coefficient of the HTS film and the stabilizing tape layer are calculated.
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