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Mon-Mo-Or3-02: Overall critical current in tapes and devices made from superconductors with critical current fluctuating along the wire length

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Fluctuation of critical current along the length of conductor is commonly observed in the 2nd generation of high-temperature superconductor tapes. In difference to low-temperature wires it seems that an elimination of this adverse feature is not a simple task. Then it would be sensible to incorporate its description in the standard tape characterization. We report on our effort to develop the procedure allowing to predict for such a tape the "overall critical current"at which the transition to resistive state takes place.
We started by analyzing the case of statistical Ic fluctuations defined by Gaussian and Weibull distributions. It was found that from the parameters describing these distributions (the mean and standard deviation in case of Gaussian distribution, the scale and the shape in case of Weibull distribution) one can nicely compute the current-voltage curve expected for the whole length of tape used in a superconducting device. This allows to establish the overall critical current even when the contribution to the total voltage comes only from a small portions of conductor. Main problem in application of this approach is that the data of industrially produced tapes usually do not fit perfectly any of these two distributions and then the predictions could fail. Significant difference is caused by weak points with Ic dropping outside the low end of statistical distribution. At currents well below the typical Ic value found in short sample testing, such locations are converted to hot spots with dissipation causing a catastrophic increase of temperature leading to a local damage.
Distinguishing between "statistical"and "unstatistical"Ic fluctuations is necessary because these two cases lead to very different behavior. For the tapes with fluctuations reliably described by a statistical model it makes sense to predict the overall critical current. In case of the tape with weak points the overall voltage is not representative and the dissipation at the weakest point defines the limitation for the current that could pass the whole device.

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