STATISTICAL ANALYSIS OF THE ELECTROMECHANICAL BEHAVIOR OF AgMg SHEATHED $Bi_2Sr_2CaCu_2O_{8+x}$ TAPES USING WEIBULL DISTRIBUTIONS

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Introduction

AgMg sheathed $Bi_2Sr_2CaCu_2O_{8+x}$ (Bi2212) conductors have great potential for future high field magnets [1] but can be limited by their electromechanical behavior. Studies of AgMg/Bi2212 tapes have shown that the microstructure is non-uniform, affecting properties. Consequently, the electrical and mechanical properties vary in different sections [2]. Hence statistical analysis is very important. Here, twenty-four samples were studied for strains of 0%, 0.25% and 0.349% for a total of seventy-two samples. The probability of electrical and mechanical failure of the tapes was analyzed using two- and three-parameter Weibull distribution functions, which are given by:

$$F(x;\alpha,\beta,\gamma) = 1 - e^{-\left[\frac{x-\gamma}{\alpha}\right]^{\beta}} : \alpha \geq 0, \beta \geq 0, \gamma \geq 0 \qquad (1)$$

In (1), x is the variable, and α, β and γ are the scale, shape and location parameters of the distribution, respectively. The method used in this analysis is described in more detail in [3].

Experimental

All I_c measurements were made at 4.2 K, self-field, using a four-point method with a 1μV/cm electric field criterion. For ε = 0% samples, I_c measurements were performed without straining. All other samples were uniaxially strained at room temperature using a linear tensile testing device to ε =0.25% and ε = 0.349% prior to I_c measurements [2].

Results and Discussion

The critical current reliability as a function of strain is shown in fig. 1 [4]. Similar data for mechanical failure showed that the mechanical failure of the tapes is homogeneous, consistent with failure in the AgMg sheath. The data in Figure 2, however, shows that electromechanical failure is inhomogeneous within the conductor and as a function of strain, indicating that this failure is dictated by failure in the inhomogeneous ceramic oxide superconducting filaments. These results are in contrast to the traditional "critical strain" model for failure in high temperature superconductors, and Bi2212 in particular.

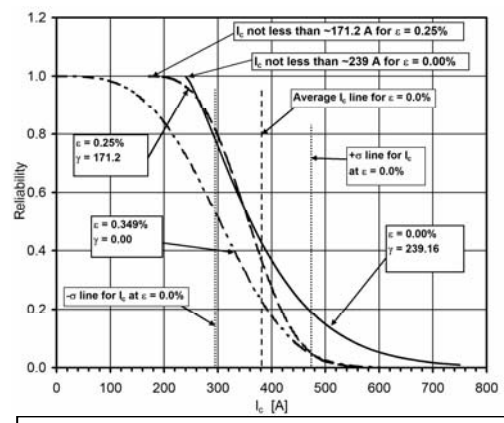

Fig. 1. Critical current reliability results with three strain conditions.

Conclusions

The metal sheath and ceramic filaments dictate mechanical and electromechanical failures, respectively in Bi2212 conductors. Understanding this behavior is important for the development of future high field magnet systems.

Acknowledgements

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References

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