FATIGUE BEHAVIOR OF Y-Ba-Cu-O COATED CONDUCTOR AT 77 K

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Introduction

Superconducting materials are subjected to various loading conditions including bending, tension, compression and fatigue, resulting from coil manufacturing, thermal cycling, quenching and normal operation. Each loading condition can affect the performance of the superconductor and thus, the magnet and system. It is important therefore to understand the electromechanical behavior of the superconducting material to optimize the design. Here, the effects of longitudinal tensile fatigue on the critical current at 77 K of YBCO coated conductors were studied.

Experimental

Samples were subjected to strain-controlled fatigue testing with maximum strains of 0.495%, 0.45%, 0.40% and 0.35% for a strain ratio of 0.2 and 0.40%, 0.38%, 0.367% and 0.35% for a strain ratio of 0.5. The total number of fatigue cycles was $2 \times 10^5$ cycles for each combination of strain and strain ratio, which was an equipment limit. As-cooled $I_c$ was measured for each sample before the fatigue testing began. $I_c$ measurements were performed at 77 K, using the four-point method at self-field and a 1 $\mu$V/cm electric field criterion.

Results and Discussion

Fig. 1. Normalized $I_c$ versus number of cycles for (a) strain ratio of 0.5 and (b) strain ratio of 0.2.

Fig 1 shows results for normalized $I_c$ versus number of cycles for strain ratios of (a) 0.5 and (b) 0.2. The results show no $I_c$ degradation for strains of 0.367% and 0.35% for strain ratio of 0.5, and for 0.35% strain for a strain ratio of 0.2. $I_c$ degraded for all other samples with increasing number of cycles. $I_c$ degradation with a strain ratio of 0.5 was not as sharp as for 0.2, indicating that crack propagation for strain ratio of 0.5 is slower than for 0.2. Similar observation was made by Shin on Bi2223 tapes [1]. Microscopy showed that crack width correlates with $I_c$ degradation.

Conclusions

$I_c$ degraded at lower number of fatigue cycles for all samples for strain ratio of 0.2 than that of 0.5, except for a strain of 0.35% for which no degradation was observed. Cracks in fatigued samples cause $I_c$ degradation, and the dependence on strain ratio is consistent with the microscopy results that show fatigue crack growth to be responsible for degradation.

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References