Strain response of GdBCO CC tapes with high critical current, I_c under magnetic field (B//c-axis)

Nowadays, REBCO CC tapes have received much attention on applications under magnetic field due to its low magnetic susceptibility. The critical current density, J_c of CC tapes has been enhanced by adopting textured substrate material which gives good buffer and GdBCO layer grain alignment. To predict the behavior of the CC tape and have a good application design (i.e. superconducting motors and generators, SMES etc.), investigating the electromechanical property response of these CC tapes under magnetic field is the first thing to be done.

In this study, two commercially available GdBCO CC tapes fabricated by reactive co-evaporation by deposition and reaction (RCE-DR) process were investigated. However, both CC tape samples have different substrate materials and thicker GdBCO superconducting film adopted. Table 1. shows the specifications of both CC tape samples in details.

Table 1. Properties of GdBCO CC tape samples

Fabrication process	IBAD RCE-DR	
Structure	Ag/GdBCO/$LaMnO_3$/IBAD $MgO/Y_2O_3/Al_2O_3$/substrate	
Superconductor	**GdBCO (~2 μm)**	
Critical current, Ic	> 200 A	
Dimension, t x w	0.194 x 4.18	0.235 x 4.15
Substrate	Hastelloy C-276 (~ 65 μm)	Stainless steel (~100 μm)
Stabilizer	Copper (~15 μm)	
Laminate	Brass (~50 μm	
manufacturer	SuNAM	

Electromechanical property of the CC tape samples was investigated under external magnetic field using the Katagiri-type loading fixture. The fixture was located at the high field laboratory superconducting magnet (HFLSM), Institute of Material Research (IMR) Tohoku University, Japan [1]. It features a loading scheme where the surface of the samples was held perpendicular to the direction of the magnetic field (B//c-axis) produced by 10 T cryocooled superconducting magnet as described elsewhere [**1**]. Length of the sample was 40 mm which includes a 10 mm grip part on both sides (lengthwise). Critical current, I_c was measured using a voltage tap separation of 10 mm and voltage criterion of 1 μV/cm. Strain was monitored by using the dual measurement scheme where two strain gauges (three-wired) are attached on both sides of the CC tape sample while a 15 mm Nyilas-type double extensometer was also installed.

As a result, similar with the one reported else-

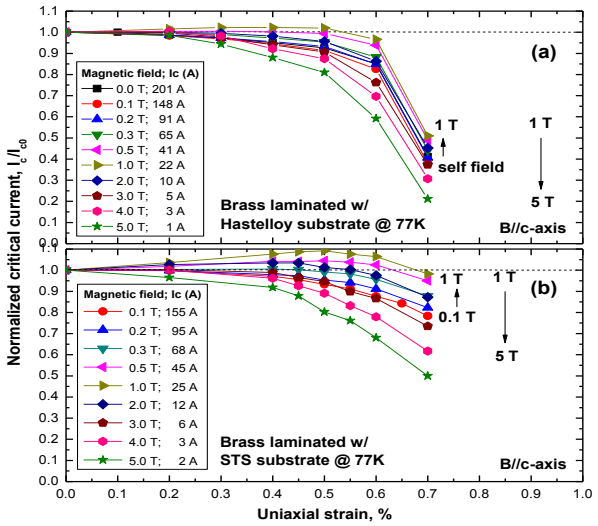

Fig.1. Normalized high critical current, I_c/I_{c0} strain dependence under external magnetic field in RCE-DR CC tapes adopting (a) Hastelloy and (b) Stainless steel substrate.

Where [2], the normalized critical current, I_c/I_{c0}-strain curves of both CC tape samples with different substrate material improved initially with increasing magnetic field up to 1 T indicating an improved strain sensitivity as shown in Fig.1. It can be observed that at 1 T, there is no sign of significant I_c/I_{c0} degradation. However, at 0.5 % strain both CC tape showed I_c peak behavior. By increasing the strain beyond 0.5 %, I_c/I_{c0} significantly dropped but the strain sensitivity of the I_c/I_{c0} curve gradually increased with increasing magnetic field up to 5 T.

As a summary, GdBCO CC tapes with different substrate and relatively high I_c due to the increased GdBCO superconducting layer thickness were significantly affected by strain under external magnetic field.

References

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