Effect of Nanorods on Critical Current Density of RE123 Coated Conductors in Low Temperature and High Magnetic Field

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Fujikura Coated Conductors (IBAD / PLD)

Ion Beam Assisted Deposition (IBAD)  Pulsed Laser Deposition (PLD)

R-to-R system with large ion source  R-to-R system with hot-wall heating
A: "High-Jc condition," with typical growth rate of 5-7nm/sec. 
B: "High-rate condition", with typical growth rate of 20-30nm/sec

Iijima et al, ASC2016, 4MOr3A-03
A purpose of this study is to understand the effect of APC on \( J_c \) properties in practical Fujikura’s tapes.

- Detailed \( J_c \) measurements were performed in high magnetic fields and wide temperature regions.
- The obtained data are compared to those of high performance By the \( J_c \) data comparison.

Sample: \( \text{EuBa}_2\text{Cu}_3\text{O}_y + 3.5\text{mol}\% \text{BaHfO}_3 \)
\[ t \approx 1 \text{ um}, I_c \approx 300 \text{ A @77K, sf} \]
Jc properties for B//c

Fujikura APC (943-1)

T=4.2, 20, 30, 40, 50, 65, 77.3 K

$J_c (A/cm^2)$

$B/(T)$
Angle $J_c$ properties

Large c-axis peak appears and shrinks with lower temperature.
Angle $J_c$ properties at 77 K

When magnetic field increases, the c-axis $J_c$ peak decreases and disappears at 10 T at 77 K.
The c-axis peak disappears at low temperatures and high fields.
$J_c$ and $F_p$ at low-$T$ and high-$B$
$F_p$ peak shifts to higher field with lower temperature.
Ideal case of nanoronds

\[ T_{r\xi}: \text{crossover temperature } (r = \sqrt{2\xi}) \]
\[ T_{dl}: \text{delocalization temperature } (d = l_{loc}) \]

\[ B_{BG}: \text{Bose glass transition} \]
\[ B_{rb}: \text{bundle field} \]
\[ B_\phi: \text{matching field} \]
$F_p$ properties

$F_p$ peak shifts to higher field with lower temperature.

$\rightarrow$ Contribution of random pinning is larger in lower- $T$!
Comparison of $F_p/F_p^{\text{max}}$ curves at 4.2 K

c-axis correlated pin  random pin
Conclusion

We investigated the flux pinning properties of practical Eu123 tapes with APC in Fujikura.

- Aligned short nanorods are found by TEM.
- The c-axis peak in $J_c-\theta$ appears in high temperature and high field region. But it disappears in low temperature.
- The flux pinning behaviors are similar to that in the LTG-Sm123 with inclined BHO nanorods.

- $F_p$ curves show the cooperation of random and correlated pinning centers. But the contribution of random pinning is more strong especially in low temperature.