Reel-to-Reel Studies of REBCO CC Degraded by High Magnetic Field Tests

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Recent progress in fabrication of REBCO coated conductors (CC) made it possible to construct the 32 T magnet and a small non-insulated (NI) test coil that produced 14.6 T in the background of 31 T resistive magnet, the world record high steady total magnetic field of 45.6 T. Recent measurements of short samples showed power law behavior of I_c up to 45 T CC except for B parallel to ab where almost no field dependence is seen. However, our postmortem examination CC test coils and cables shows that it is rather the mechanical strength that decides performance in high magnetic fields.

Our principal tool is a continuous measurement transport critical current tool (YateStar) that applies 0.6 T perpendicular and parallel to the tape at 77 K, thus allowing variations of *c*-axis and *ab*-plane properties to be clearly distinguished in the temperature and field regime where strong pinning defects are obvious. Our detailed study of the position-, angular-, field-, and temperature-dependence of $I_C(x)$ clearly shows that cross-section variations alone cannot explain $I_C(x)$ variations. To the contrary, we find that the dominant source of I_c variation is due to pinning center fluctuations that control J_c, rather than to cross-section changes. However, in tapes deconstructed from test coils and cables, it is rather obvious that current is limited by cross sectional defects generated by degradation induced by high magnetic field forces. Especially concerning is out-of-plane Lorentz forces at coil ends that induce edge-peeling from damage induced by slitting during manufacture. Detailed analysis of $I_C(x)$ indicates a damage periodicity that often agrees with the local winding circumference, strongly suggesting hoop strain damage. Periodic changes that not correspond to coil dimensions probably stem from latent production defects or stick-and-slip process during winding.

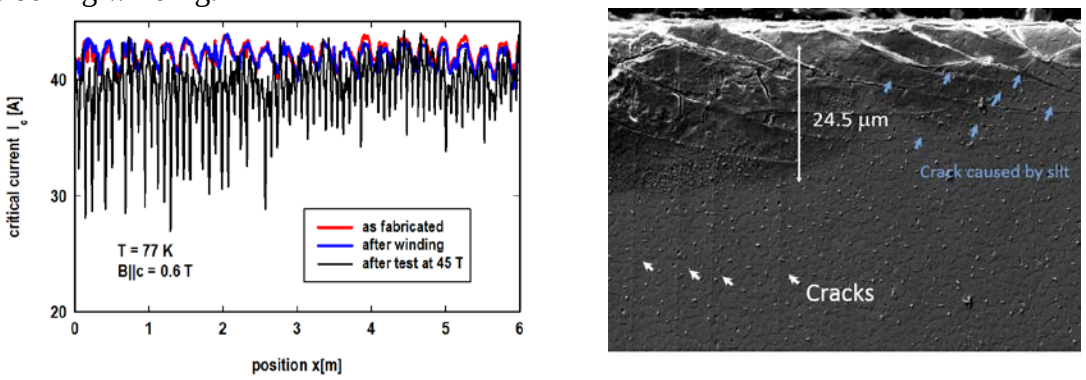

Figure: (a) I_c vs. position measured in REBCO CC conductor before and after winding a coil (upper traces) and after high field degradation.(lower trace). Period in upper traces corresponds to circumference of slitting knife while that in lower trace matches the coil dimensions (b) SEM micrograph shows cracks across the tape as well as cracks caused by slitting process on the edge.

Different kinds of defects identified in reel-to-reel measurements and analyzed by MO, SEM and TEM are discussed together with suggestions how to minimize conductor degradation in high field applications..

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