

Development of REBCO Superconducting Coils for MRI Operating in Subcooled LN₂ at 65 K

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Abstract – We are developing superconducting magnets for 3 T MRI with REBCO tapes. We intend to operate the superconducting magnets at 65 K bath-cooling with subcooled liquid nitrogen. It will bring us high stability due to a large heat capacity at high operating temperatures and very good cooling with liquid nitrogen. To realize a 3 T superconducting magnet at 65 K, we are developing EuBCO superconducting tapes with BaHfO artificial pinning centers. We have already attained an I_c of 616A at 65 K and 3T for a 10mm wide tape with a 2 micron thick EuBCO layer. MRI magnets need high uniformity of its magnet field in time and space. The disturbance is mainly caused by the shielding current induced by the perpendicular component of the applied magnetic field to a tape face. In this study, we made small test coils with scribed and non-scribed REBCO tapes and investigated the influence of shielding currents on the produced magnetic field by observing the magnetic field variation at the coil center. REBCO tapes, 5mm wide, were wound into multilayered solenoid coils with an inner diameter of 78 mm. Test coils were inserted into a NbTi superconducting magnet, which provide a dc bias magnetic field of 0 to 2 T. Test coils were cooled down to 65 - 77 K with subcooled liquid nitrogen. The transport current was increased up to around I_c step by step with an interval of a few to tens A. At that time, the variation of the produced magnetic field at the coil center was observed by a hall probe with high accuracy. We derived a fitting expression for the observed magnetic field variations so as to quantitatively investigate the influence of the shielding current on the produced magnetic field, especially on the magnitude and the decay time constant of the shielding current. The fitting expression was composed of an exponential term and logarithmic one. As a result, the dependences of the decay time constant of the shielding current on transport current and magnetic field were revealed. The decay time constant increased with transport current up to around 80 % of I_c . However, the decay time constant decreased abruptly with further increased transport currents. It seems to be caused by the equivalent resistance which originated from the I-V curve with a small gradient, i.e. a small n-value. Furthermore, it was shown that the scribing

of REBCO tapes resulted in a quick decay of shielding currents.

In CCA 2016 we reported the details of the observed results and propose methods to reduce the influence of shielding currents and to enhance the decay of shielding currents.

Keywords, Index Terms— Bath-cooling with liquid nitrogen, coated conductor, MRI, scribing, shielding current.

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