AP3-1-INV

HTS flux pumps and the role of dynamic resistance in the HTS flux pump

*Zhenan Jiang[1], Chris W Bumby[1], Rodney A Badcock[1], Andres E Pantoja[1], Kent Hamilton[1]

Victoria University of Wellington[1]

Flux pump devices enable large currents to be injected into a superconducting circuit without the requirement for normal-conducting current leads. The demonstration of an efficient HTS flux pump could reduce the system heat load incurred whilst energizing HTS coils. Furthermore, brushless HTS exciters can be implemented using flux pumps for HTS rotating machine application [1].

In recent years, we have developed and studied a series of HTS coated conductor dynamo-type flux pumps:(1) G1 (generation 1) flux pump with radial flux gap where permanent magnets mounted on a cylindrical rotor move across a coated conductor stator [2-4]; (2) G2 flux pump with axial flux gap and iron return paths for through-wall excitation of HTS coils [5]; (3) G3 flux pump with radial flux gap with continuous cylindrical coated conductor stator for kA-class current pumping; (4) G4 flux pump with radial flux gap with parallel connected coated conductors and iron return paths. The design features and the output characteristics of these flux pumps will be reviewed.

Dynamic resistance occurs in a HTS wire carrying a DC transport current whilst simultaneously experiencing an AC magnetic field. HTS flux pumps are found to possess an effective internal resistance, which varies linearly with frequency. This internal resistance, which is due to dynamic resistance [6], sets a limit for the maximum achievable output current from the flux pump.

We discuss the dynamic resistance characteristics in coated conductors in perpendicular magnetic fields first, and then present the role of dynamic resistance in various types of HTS flux pumps.

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Keywords: HTS flux pump, Dynamic resistance, Coated conductors

AP3-2-INV

Two-shell Superconductor/Ferromagnetic Cloaks for Shielding of Magnetic Fields

*Fedor Gömöry[1], Mykola Solovyov[1], Ján Šouc[1]

Institute of Electrical Engineering, Slovak Academy of Sciences, Bratislava, Slovakia[1]

Covering a superconducting shield with ferromagnetic layer allows to absorb the magnetic flux expelled from the shielded space. In difference to a common magnetic shield, such cloak could be made invisible to a detector of magnetic field. We have demonstrated such possibility utilizing rather common materials, the 2nd generation HTSC tape and an iron alloy tape.

Further development towards a possible application requires a substantial expansion of dimensions and a reduction of energy dissipation in AC fields. Several options for design of the cloak considered for operation at low fields, with amplitude below 1 mT, have been investigated. Dimensions of 10 cm scale can be reached using *RE*BCO coated conductor tapes arranged in helically wound co-axial layers. The outer ferromagnetic tube can be made of a composite containing ferrite powder in suitable compacting medium. Experimental verification of cloaking ferromagnetic and metallic materials brought satisfactory results. Possible ways of improving the cloak performance will be analyzed and imaginable applications of this novel superconducting device discussed.

Keywords: magnetic cloaking

AP3-3-INV

Numerical Analysis of Current Distribution and Stability in No-Insulation Coils Wound with REBCO Wires

*So Noguchi[1,2,3], Seungyong Hahn[2,4], Atsushi Ishiyama[5], Yukikazu Iwasa[3]

Graduate School of Information Science and Technology, Hokkaido University[1]
National High Magnetic Field Laboratory, Florida State University[2]
Plasma Science and Fusion Center, Massachusetts Institute of Technology[3]
Department of Electrical and Computer Engineering, Seoul National University[4]
Department of Electrical Engineering and Bioscience, Waseda University[5]

With the development of No-Insulation (NI) winding technique [1], coils wound with REBCO wires have been applied to generate a higher magnetic field than 20 T. MIT is making a 1.3-G NMR, and NHMFL has generated >40 T using the NI technique. The NI technique is the best way to protect REBCO coils so far. If a REBCO coil quenched, the coil would not be damaged. Although NI REBCO coils show good properties, the electric and thermal behaviors inside the coils are very complicated. To clarify such behaviors, we have developed a simulation method coupling with a partial element equivalent circuit (PEEC) method and a thermal finite element method (FEM) [2]. Fig. (a) and (b) shows the circumferential current and temperature distributions at 3 s after the bottom REBCO pancake entirely quenched. Using the PEEC and FEM method, the high thermal stability of NI REBCO coils were shown.
Many experiments of small-size NI REBCO magnet were done before, however a few experiments of high magnetic field generated by magnets of insert NI REBCO magnets and outsert LTS magnets have been reported recently. In such experiments, behaviors which have never seen in low magnetic fields can be observed, such as a torque and a Hall voltage. Therefore, we have developed a new simulation method to consider a torque and a Hall voltage after quenches, to investigate the stability of NI REBCO magnets as an insert magnet.

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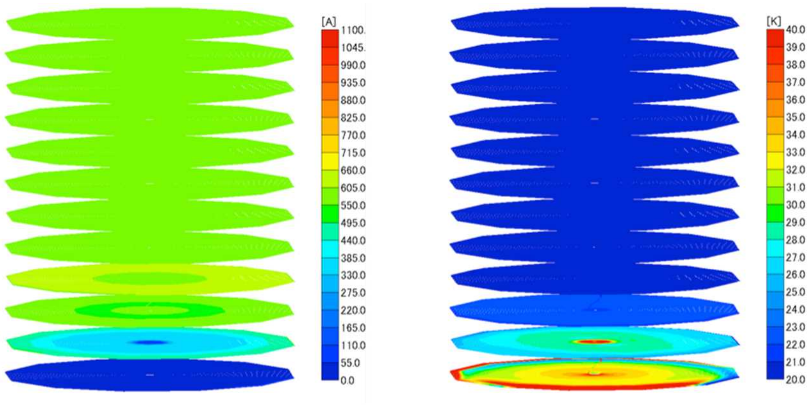

(a) (b)

Fig. (a) Circumferential current distribution and (b) temperature distribution at 3 s after the bottom REBCO pancake quenched.

Keywords: No-Insulation winding technique, Thermal stability, Numerical simulation

AP3-4

Transient Heat Transfer Through the LHC Polyimide Cable Insulation

*Tiemo Winkler[1], Marcel ter Brake[1], Torsten Koettig[2], Rob van Weelderen[2]

University Of Twente, The Netherlands[1]
CERN, Switzerland[2]

During the operation of the LHC, the superconducting magnets are exposed to steady-state and transient heat loads. Knowledge of the thermal link between the superconductor and the He bath is essential to evaluate the stability of the superconductor. This work reports experimental data on the transient heat transfer between a stack of MB Rutherford superconducting cables and a He bath in saturated and pressurized conditions. The sample is prepared from machine insulated superconducting cable, instrumented with a Cernox temperature probe. The heat transfer is studied in the temperature range 1.7 K to 2.1 K and a deposited power range in 0.5 mW/cm3 to 5 mW/cm3.

From the experimental data, two parameters are extracted and are discussed. The first parameter is the steady-state temperature difference and the second parameter is the characteristic time for the temperature difference to reach steady-state. From the two parameters conclusions are drawn on the void volume in the sample and on the dominant cooling paths through the polyimide insulation.

Keywords: Helium II, Transient Heat Transfer, Polyimide Cable Insulation