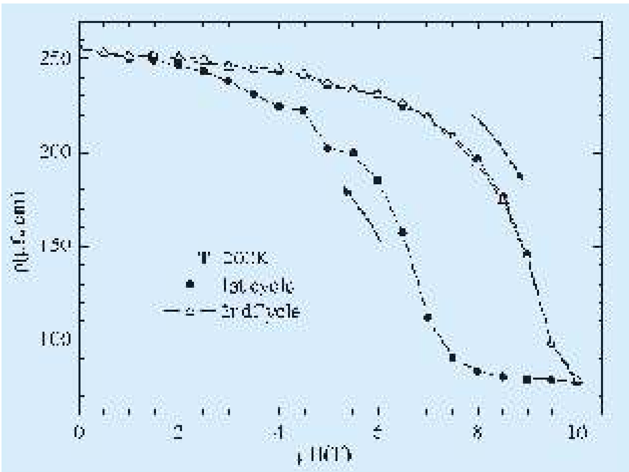

Fig.A.2.2 Isothermal field dependence of resistivity of $Ni_{50}Mn_{34}In_{16}$ at 200K. The arrows indicate direction of field change.

The inset to Fig. A.2.1 shows MR as a function of T for $Ni_{50}Mn_{34}In_{16}$ in magnetic field of 5T. An MR of 64% is obtained in 5T magnetic field at 230K. Even for a moderate magnetic field of 1T, an MR as large as 46% is obtained. On increasing the magnetic field to 10T, the MR may be enhanced to 75%. It has been observed that the martensite to austenite phase transition can be induced by magnetic field as well. This is shown in Fig.A.2.2. The field induced transition is also hysteretic, highlighting the first order nature of the transition. But if the martensite to austenite transition is induced by magnetic field at temperatures above 230K, the alloy does not return to the martensite phase on reducing the field back to zero. It remains arrested in the austenite phase withstanding any number of subsequent field cycling. The alloy returns to the martensite phase completely only when it is cooled to 100K or lower [see for details, *V. K. Sharma et. al; Appl. Phys. Lett. 89, 222509 (2006)*]. Thus apart from the very large MR, $Ni_{50}Mn_{34}In_{16}$ also has interesting memory effects that make it important as a potential ferromagnetic shape memory alloy. We are therefore continuing further studies on the different characteristics of $Ni_{50}Mn_{34}In_{16}$ and their dependence on the thermal annealing treatments.

Contributed by:
V. K. Sharma (vishnusharma@cat.ernet.in) and
M. K. Chattopadhyay (maulindu@cat.ernet.in).

A.3 : Testing of high T_c superconducting current leads

High T_c superconducting (HTS) current leads are finding increasing scope in powering of Superconducting (SC) devices on account of their high electrical conductivity and low thermal conductivity at temperature easily achievable using liquid nitrogen.

Regional Research Laboratory, Trivandrum (RRL-T) has taken up a DAE-BRNS project with RRCAT as principal collaborator for the development of general-purpose HTS current leads for direct application in high current SC magnet systems. The HTS leads were made using Pb doped Bi-Sr-Ca-Cu-O (Bi-2223) tapes sheathed with Ag-Au-Cu alloy housed inside stainless steel tubes. The testing of these HTS current leads has been done with joint efforts of Magnetic & Superconducting Materials Section, and Superconducting Technology Lab of AAMD, RRCAT, using the cryogenic test facility available at the Superconducting Technology Lab. The tests conducted were measurement of self-field critical current I_C and Voltage (V) – Current (I) characteristics at 77 K, operational stability at ~77 K and field trial with a SC magnet.

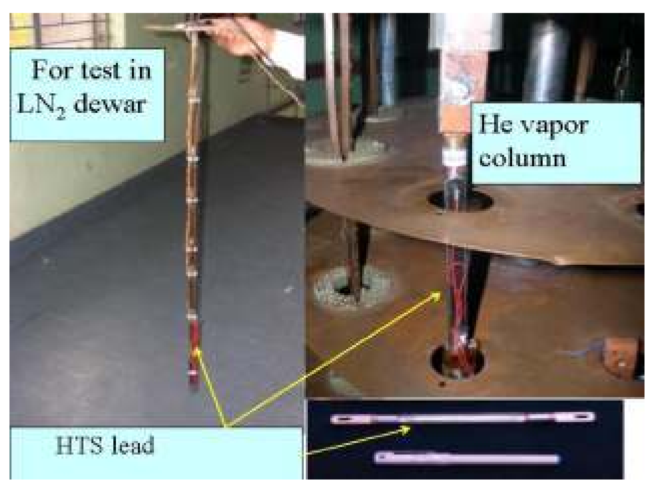

Fig.A.3.1 : HTS current leads and their testing configurations.

RRL-T had sent five current leads each 10 cm long, rated for 100A, 200A & 500A at 77K, designated as 100/1,100/2, 200/1, 200/2 and 500/1 .The testing of the leads at liquid nitrogen temperature was conducted in a standard liquid nitrogen dewar by using a special insert. The evaluation of operational stability of these leads at temperatures below the liquid nitrogen temperature, was conducted in a liquid helium cryostat. For this the HTS leads were connected in series with the conventional copper current leads in the vapor column (Fig.A.3.1) of the cryostat feeding a SC magnet dipped in liquid helium.

All the electrical measurements were carried out using the standard four-probe method using a nano-voltmeter (Keithley 182) with power fed by 1200A-3V current source. The current was ramped at the rate of 0.5 A/Sec. The critical current I_C is defined to be that value of current, which generates an electric field of 1 μV/cm across the HTS leads. This exercise was repeated to observe the reproducibility after thermal cycling.

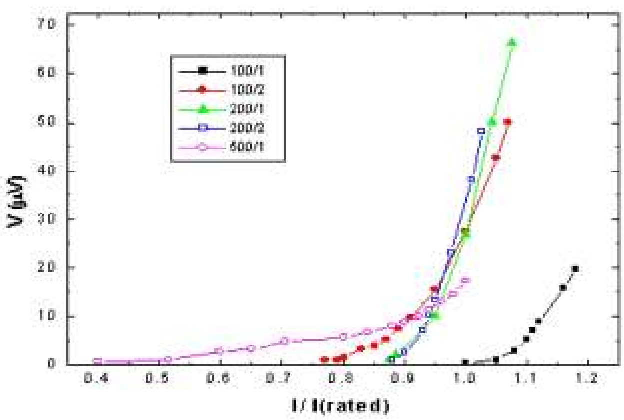

Fig.A.3.2 : The V-I characteristics of the HTS leads

The V-I characteristics (Fig.A.3.2) of the HTS leads were determined by increasing the current in discrete steps and recording the corresponding voltage drop. After each increment in the value of current, sufficient time delay was given to get the steady state voltage drop. This was done to ensure that the HTS lead was operating in thermal equilibrium with the surrounding liquid nitrogen. The measurements were continued till the voltage drop across the leads reached up to the level of 60 μV. Similar exercise was repeated both while increasing and decreasing the current.

The long duration testing at T~77 K was done by ramping the current up to 90 % of I_C. The current was kept stable at this value and then the voltage was recorded across the leads with respect to time. No thermal runaway was observed over a period of about 5 hours. To evaluate the operational stability of the HTS leads at temperatures below 77K, two leads marked 100/1 & 100/2 were connected to feed a current of 1000 A to a SC magnet for duration of about an hour. The temperatures recorded (using DT-470) were from 10 to 30 K The leads showed a stable behavior in the helium vapor column and did not show any thermal runaway with this current level at temperatures below 77K.

In conclusion, the critical current carrying capacity of five HTS leads has been evaluated at liquid nitrogen temperature. All the leads showed a stable behavior with respect to time, at liquid nitrogen temperature and there was no degradation in the self-field I_C after passing current for time periods of about 5 hours. The leads showed no signs of thermal runaway when they were connected to a SC magnet powered with a current of 1000A. This stable behavior at such a large current was consistent with the expectation that the I_C would enhance by about 4 to 5 times as the temperature is lowered.

Contributed by:
Anand Yadav (anandyadav@cat.ernet.in) and
MA Manekar (megh@cat.ernet.in)

A.4 : Status of Indus controls

Indus control system is under continous evolution in order to fulfill the new requirements and offer enhanced features and services to users. Following newer aspects need mention:

1. New Independent References for Booster Quadrupole Power Supplies (Qd & Qf):

The earlier scheme provided for currents in quadrupole supplies (Qd, Qf) with linear proportionality to main dipole current. It is however felt that to get a better performance of the synchrotron, (1) the quadrupole strengths should be changed in a complex manner during ramping, (2) the reference of the QP secondary power supply should vary independently based on the look up table to provide greater flexibility of the QP strengths. Accordingly a new scheme for energizing the quadrupole power supplies of booster synchrotron has been developed. The output of the booster dipole current is given to the reference input of the multiplying DAC through the isolation (Fig A.4.1). The reference is generated as y = m x + c where x is the input from booster dipole current, m is the multiplying factor, and c is the offset.