

AUTOMATIC MEASURING SYSTEM

AMT&C LLC offers automated system intended for measuring magneto-thermal and other magnetic parameters and including:

- PC controlled magnetic field source,
- liquid nitrogen cryostat,
- data acquisition system,
- measuring inserts.

Regulated PM magnetic field source

Adjustable magnetic field system on the basis of two nested dipole Halbach-structures of permanent magnets is characterized by low power consumption and low weight. It provides a magnetic field of up to 1.8 T in a working bore of 36 mm in diameter with a field sweep rate up to 6 T/s. The mechanical system of the magnetic field source is guided by a step motor and provides synchronous rotation of two subsystems in opposite directions, so the resulting field vector is directed along the same line during all the field changing cycle with preservation of good field uniformity. The magnetic field source is assembled as a separate unit with power source, the mechanical system and the stepping motor with electronic driver.

The magnetic field source characteristics:

- variable magnetic field strength: from -1.8 to +1.8 T,
- overall size: 396×324×482 mm,
- weight: 106 kg;
- working bore diameter: 36 mm;
- dimensions of the magnetic field area with heterogeneity no more than 0.5 %: $\varnothing 10 \times 13$ mm;
- magnetic field changing rate: up to 6 T/sec;
- magnetic field change frequency (in the mode of continuous cycling): 0.1 - 1.8Hz;
- magnetic field temperature change: no more than -0.2 %/K;
- material of the magnetic system: NdFeB;
- maximal power consumption: 700 W.



Liquid nitrogen cryostat

Liquid nitrogen cryostat makes it possible to carry out measurements in the temperature range from 80-100 up to 370 K. The cryostat is equipped with a shank allowing the measuring insert, cooled from the outside to the liquid nitrogen temperature, to be placed in the working bore of the magnetic field source. Liquid nitrogen inside the cryostat provide cryogenic temperature in a measuring insert and together with the heater placed on insert sample holder gives a possibility to establish necessary temperature inside the working temperature interval.

The cryostat characteristics:

- liquid nitrogen holding capacity: 9 liters;
- liquid nitrogen complete evaporation time (without measuring insert): no less than 36 hours;
- weight: 15 kg;
- outer diameter: 314 mm;
- total height: 713 mm;
- the inner diameter of the shank: 23 mm;
- the outer diameter of the shank: 34 mm.

Measuring inserts set

The set of measuring inserts is intended for measurement of field and/or temperature dependences of:

- the magnetocaloric effect by a direct method,
- magnetization by induction method,
- heat capacity by the adiabatic method,
- thermal conductivity by a stationary method.



The measuring inserts consist of two parts – outer case and inner insert equipped with sample holder with necessary sensors (Hall sensor, resistive temperature sensors, thermocouple, measuring coils etc.) and resistive heaters. The outer case and inner insert are also equipped with clamp-type flanges, which allow to connect them between each other and with vacuum system quickly and easy, and vacuum electric feedthroughs. During measurements, the inner insert is placed in the outer case. The inserts operating temperature range is from 80 to 370 K.

The magnetocaloric measuring insert

is intended for direct measurement of adiabatic temperature change induced by the change of magnetic field. The adiabatic temperature change is displayed by any magnetic material and is one of manifestations of the magnetocaloric effect.

The inner magnetocaloric measuring insert sample holder is equipped with the resistive heater, Hall sensor, thermocouple and resistive temperature sensor.



The magnetocaloric measuring insert characteristics:

- measurement accuracy of magnetocaloric effect: 0.1 K;
- outer diameter: 18 mm;
- weight: 3 kg;
- sample and its maximal dimensions: two plates $1 \times 4 \times 8$ mm.

The magnetization insert

is intended for measuring field and temperature dependences of magnetization by an induction method. Its inner sample holder is equipped with the resistive heater, resistive temperature sensor and measuring

coils. The sample is placed into one of the coils (a measuring coil), the other coil (a field coil) is used to measure the magnetic field strength. The signal taken from the measuring coil is proportional to the magnetization and is induced with a change of the external field. It is recorded continuously simultaneously with the signal from the field coil proportional to the external magnetic field strength magnitude.



The magnetization measuring insert characteristics:

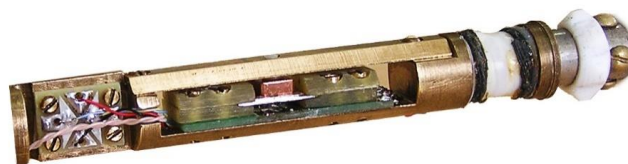
- relative measurement accuracy of magnetization: 2 %;
- outer diameter: 18 mm;
- weight: 3 kg;
- sample and its dimensions: a rod with length up to 3.5 mm and diameter up to 1.3 mm.

The heat capacity measuring insert

is intended for measurement of the heat capacity temperature dependencies in constant magnetic field. In this insert the adiabatic method is used. The inner heat capacity measuring insert sample holder is equipped with the resistive heaters, resistive temperature sensors and Hall sensor.

The heat capacity measurement insert characteristics:

- relative measurement accuracy of heat capacity: 3 %;
- outer diameter: 21 mm;
- weight: 3 kg;
- sample and its dimensions: a rectangular bar $4 \times 5 \times (1-1.5)$ mm.



The thermal conductivity measuring insert

is intended for measurement of the thermal conductivity coefficient temperature dependencies in constant magnetic field using stationary method. The inner sample holder is equipped with the resistive heaters, resistive temperature sensors and Hall sensor.

The thermal conductivity measuring insert characteristics:

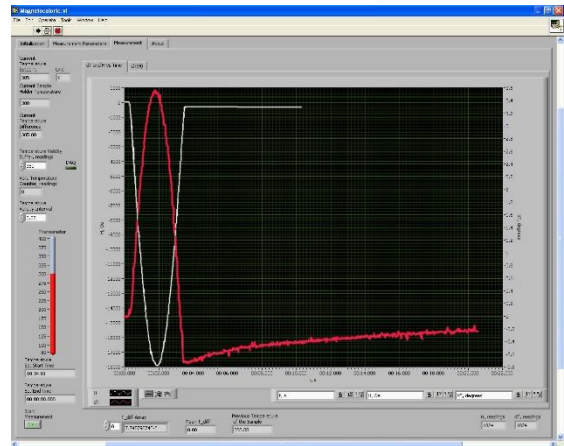
- relative measurement accuracy of thermal conductivity coefficient: 3 %;

- outer diameter: 18 mm;
- weight: 3 kg;
- sample and its dimensions: a rectangular plate 22×4×2 mm.

Data acquisition system

Data acquisition system allows to carry out experimental measurements in manual and automatic modes. It includes:

- temperature measuring and control system
on the basis of temperature controller;
- magnetic field source control system;
- magnetic field measuring system;
- universal measuring system;
- controlled power supply system;
- control computer with control software.



Temperature measuring and control system on the basis of temperature controller together with temperature resistive sensors and resistive heaters allows to set the desired measurement temperature and the cooling or heating rate. The magnetic field measurement system is used to measure the magnetic field during obtaining field dependences of the magnetocaloric effect and magnetization, and also to monitor a constant magnetic field when measuring heat capacity and thermal conductivity. The change of the magnetic field at a given rate and the setting of the required value of the constant magnetic field is provided by the magnetic field source control system. Universal measuring system serves to measure signals from sensors of measuring inserts and the magnetic field measuring system. The controlled power supply system is used to generate heat by measuring heaters of measuring heat capacity and thermal conductivity inserts. The process of measuring and data acquisition is controlled by a computer with software on the basis of the software package LabView. The data acquisition system can be placed in a separate 19-inch rack or in a desktop unit.

All measuring equipment is produced under registered trade mark “MagEq”.



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