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Physics

Cryostat for Investigation of Superconductors

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ABSTRACT. Multifunctional experimental cryostat – plant CS-IDMB of folding design construction for investigation of superconductors by the AC method of linear and nonlinear susceptibility in the temperature range of 4.2-300 K is described in the paper. The construction of cryostat is made of nonmagnetic materials; the surfaces are polished and sprayed with copper and silver. Research sample of superconductor can stay in the medium of liquid helium or liquid nitrogen, also in the vacuum with medium of inert gases at 63-300 K. High stability in temperature and pressure allow to conduct investigation of superconductors with high accuracy. Construction of the cryostat is shown. The results of the experiment of cryostat carried out at the temperature of liquid nitrogen are presented. *© 2014 Bull. Georg. Natl. Acad. Sci.*

Key word: *cryostat, superconductor, solenoid.*

Experimental methods and plants capable to distinguish the nature of physical processes in the superconductors providing recurrence of the results and proving the truth of theoretical models are very important for investigation of superconductors. Some cryostats of original constructions for investigation of superconductors by different methods magnetomechanical, optic, Mössbauer, radiotechnical and for solution of the other topical problems have been created [1-3].

In the present paper we introduce the multifunctional plant - cryostat CS-1DMB of folding design construction for investigation of high [4] and low temperature [5] superconductors by linear and nonlinear susceptibility methods.

In Fig.1 the scheme of cryostat is presented. It consists of body (case) (1) with connected flange (2) in the upper part and attached flange below (3), upper cover 4 with flanges and cap (5), nitrogen vessel (6) with screen and attached flange (7), helium vessel 8 with attached flange (9) ; sample input rod (10) and vacuum cavity (11) .

On the upper cover 4 two thin-walled pipes of the suspension (12) of the nitrogen vessel (6) for filling of liquid nitrogen and vapour outlet. Pump-down of vacuum cavity (11) up to 1.10^{-4} Pa is provided through high vacuum valve (13) connected to autonomous high-vacuum system. Filling of liquid helium is done through the pipe (14), and vapour outlet occurs through pipe (15) on the cap (5). Communication slots (16) are aimed for input and information control on temperature, magnetic field and characteristics of superconductor. An original construction "stack" (17) hanging on the cap (5) is made

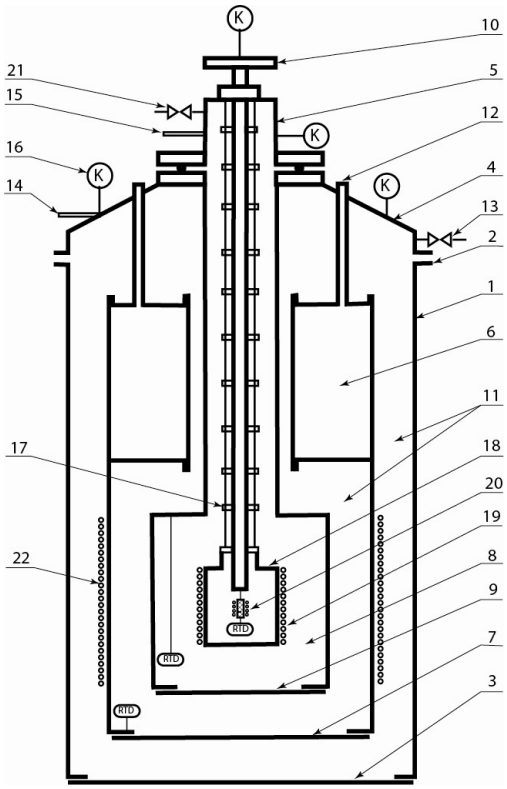

Fig. 1. The scheme of cryoststat CS-1DMB of knock-down construction.

of dielectric materials at the end of which copper cylinder (18) with heater is installed. Rod (10) with communication slot (16) is aimed for input of the superconductor research sample of into central part of the cylinder (18). The investigated sample (20) is placed in the field of excitation search coil. Pumping down and filling of gas of helium is down by means of vessel valve (21). The controlled magnetic field around the superconductor is created by solenoid (22). Pumping down of vapours of liquid nitrogen to decrease the temperature occurs through one of the pipes of the suspension (12). The control and management of the processes in cryostat is carried out by means of RTD detector.

Cryostat CS-1DMB is directed for investigation of superconductors in the range of temperatures 4.2-300 K. Cooled sample of the superconductor can stay in the medium of the liquid hlium of liquid nitrogen, also in the vacuum, in the medium of inert gases at the temperatures 30-300 K and 63-300 K.

Body 1, upper cover 4 and cap 5 are made of stainless steel 12x18 H10T. Nitrogen 6 and helium 8 vessels are made of thin- walled stainless steel, all the surfaces of which facing vacuum cavity are polished thoroughly and sprayed by copper and silver. Communication slots (K) are standard and made of non-magnetic materials.

In Fig. 2a the construction of "stack" presenting a set made of thermostable dielectric materials and aimed for thermodynamic stabilization of the system on temperature and pressure is shown. At the end of "stack" the cylinder with heating element (Fig.2b)

a

b

Fig. 2. a) General view of "stack" with the cap and cylinder; b) General view of cylinder with heating element

a

b

Fig. 3. a) Cryostat with undressed case; b) General view of cryostat.

where the investigated superconductor is placed by means of a rod, is rigidly fixed. The temperature control 42-300K in the cylinder is performed by CH7200 controller. Maximum current used by heater is 100 mA.

Superconducting sample 20 (Fig. 1) in the cylinder is placed in the field of excitation search coil with intensity 0-1 oersted. Control and management is done by RTD system (PT-100) with thermistor of DIN EN 60715 standard by means of number registrator Endress+Hauser RSG30.

In Fig.3 the cryostat CS-1DMB with undressed case and solenoid coiled on nitrogen screen with intensity of the magnetic field in the centre 100 oersted is presented. General view of cryostat CS-1DMB is presented in Fig. 3b

The CS-1DMB cryostat research at "self on itself" regime at the temperature of liquid nitrogen LN_2 show: spread of temperature field is not more 1K; discharge of LN_2 is not more than 0.25 l/day; high vacuum hermeticity. At working regime: the temperature field spread is not more 2K; discharge LN_2 is not more than 0.65 l/day; reliability of communication systems. Technical parameters of cryostat CS-1DMB are: diameter on the body 150 mm, general height 600 mm, capacity of the vessel with liquid nitrogen – 4 l, liquid helium vessel capacity 1 l, vacuum sealings are made of indium, weight is not more 5 kg.

The obtained experimental data are well agreed with the already known results [6,7].

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ფიზიკა

კრიოსტატი ზეგამტარების შესასწავლად

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წარმოდგენილია მრავალფუნქციონალური ექსპერიმენტალური დაშლადი დანადგარი - კრიოსტატი CS-1DMB, ზეგამტარების წრფივი და არაწრფივი ამთვისებლობის მეთოდებით კვლევებისათვის ტემპერატურის 4.2-300K დიაპაზონში. კრიოსტატის კონსტრუქცია შესრულებულია არამაგნიტური მასალებით, რომელთა ზედაპირები პოლირებულია და დაფენილია სპილენძითა და ვერცხლით. ზეგამტარი საკვლევი ნიმუში შესაძლოა იმყოფებოდეს თხევადი აზოტის ან თხევადი ჰელიუმის გარემოში, ვაკუუმში, ინერტული აირების გარემოში 63-300K ტემპერატურაზე. ტემპერატურის და წნევის მიმართ მაღალი სტაბილურობა საშუალებას გვაძლევს მაღალი სიზუსტით ჩავატაროთ ზეგამტარების კვლევა. ნაჩვენებია კრიოსტატის კონსტრუქცია და ფოტომასალები. მოყვანილია თხევადი აზოტის ტემპერატურაზე ჩატარებული კრიოსტატის კვლევის შედეგები.

REFERENCES

1. *M.P. Larin* (2011) Vakuumnaiate khnika i tekhnologiia, **21**, 1: 21-23 (in Russian).
2. *V.L.Miloshenko, T.I.Kasatkina* (2011) Zavodskaia laboratoria. Diagnostika materialov, **77**, 4: 31-24 (in Russian).
3. *G. Sporl, A. Binneberg, M. Bohm, R. Stangl* (2000) Proceedings of the Sixth International Conference IIR: 25-25, Prague, Czech Republic, October 10-13, 2000.
4. *I.R. Metskhvarishvili, G.N. Dgebuadze, B.G. Bendeliani, T.E. Lobzhanidze, M.R. Metskhvarishvili, G.N. Mumladze* (2014) Low ac field response of Bi-based superconductors with edition of antimony oxide. Journal of Physics: Conference Series 507 012032.
5. *I.R. Metskhvarishvili, G.N. Dgebuadze, B.G. Bendeliani, T.E. Lobzhanidze, M.R. Metskhvarishvili, G.N. Mumladze* (2013) J. Low Temperature Physics, **170**, 1-2: 68-74
6. *G. Dgebuadze, L. Tsaqadze* (2009) Bull. Georg. Natl. Acad. Sci., **3**, 3: 76-80.
7. *G. Dgebuadze, M. Mumladze, T. Sordia, L.Tsaqadze, V. Chanturidze* (2010) Bull. Georg. Natl. Acad. Sci, **4**, 3: 63-65.

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