CRITICAL VALUES OF THE CURRENT IN SUPERCONDUCTING WIRES AND RIBBONS COATED WITH Nb_3Sn

F. F. DETTMANN and F. K. LANGE

East German Academy of Sciences, Low-Temperature Physics Laboratory, Dresden

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The critical currents were measured in niobium wires and ribbons coated with Nb_3Sn at temperatures above 14°K in transverse magnetic fields having intensities of up to 30 kOe. The critical current for ribbons depended on the orientation of the plane of the ribbon in the field.

THE critical currents in niobium wires and ribbons coated with Nb_3Sn were investigated at temperatures above 14°K in transverse magnetic fields up to 30 kOe. The samples were prepared as follows. The wires (0.1 mm in diameter) and the ribbon ($15\,\mu$ thick, 0.5 mm wide) were cleaned with emery paper and coated with a layer of tin in a bath containing sodium stannate. The quantity of tin deposited was controlled in such a way that the increase of mass after heat treatment represented an amount corresponding to a layer of Nb_3Sn $5\,\mu$ thick. The heat treatment was carried out in apparatus described earlier. [1]

To protect the samples (5 cm long) from mechanical damage, they were placed in tubes of fired corundum to which leads were attached (by means of indium solder). Some samples in the form of ribbons were attached to these tubes by means of BF-2 adhesive. The contact resistance amounted approximately to $10^{-4}\,\Omega$. The sample resistance at room temperature was about 0.7—1.4 Ω. The ratio of the resistances R(20°K)/R(293°K) ranged from 0.15 to 0.25. To protect the samples from damage on their transition to normal conduction, we connected up a parallel resistance, amounting to $10^{-2}\,\Omega$, and a galvanometer was connected to the potential terminals of this resistance. Moreover, we measured the potential drop between the potential terminals of the superconductor.

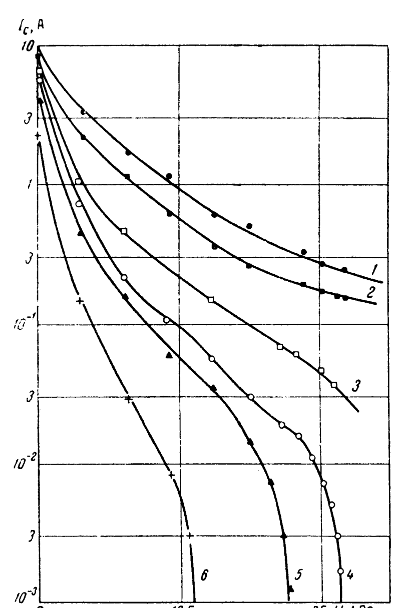

FIG. 1. Dependence of the critical current on the magnetic field at the following temperatures (°K): 1) 14.1; 2) 14.9; 3) 15.7; 4) 16.4; 5) 16.6; 6) 17.2.

To determine the dependence of the critical field on the magnetic field intensity, the samples were placed in a special cryostat between the conical pole-pieces of an electromagnet, the former being separated by a gap of 8.5 mm and having a frontal area 20 mm in diameter.

At a distance of 8 mm from the symmetry axis,

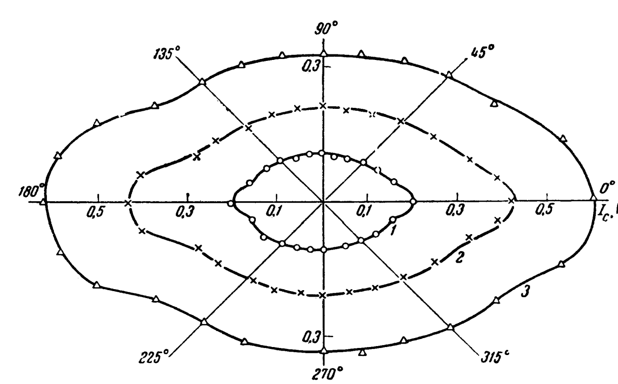

FIG. 2. Dependence of the critical field on the sample orientation in the magnetic field at the following temperatures (°K): 1) 16.2 (8.54 kOe); 2) 14.1 (25.4 kOe); 3) 14.1 (19.1 kOe).

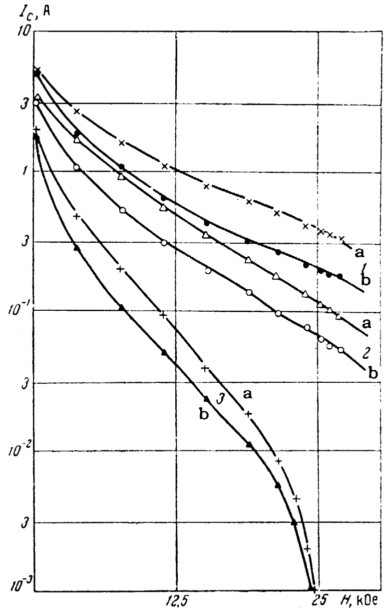

FIG. 3. Dependence of the critical current on the magnetic field for various orientations of the ribbon at the following temperatures (°K): 1) 14.3; 2) 15.1; 3) 16.2. a) The normal perpendicular to the field; b) the normal parallel to the field.

the field was still almost uniform but beyond this distance its intensity fell rapidly. Thus, we were able to place the contacts in a field of relatively low intensity, thereby avoiding (except in weak fields) possible experimental errors due to disturbances at the contacts. When the contacts were placed at points where the field was a maximum, the critical current was reduced to 40–90% of its initial value. The results of measurements at 14°K in fields H = 0 and H = 30 kOe are listed in the table for all the investigated samples. Figure 1 shows the dependence of the critical current on the field intensity for sample No. 1 at various temperatures. For ribbons, we observed a dependence of the critical current on the orientation in the field, as shown for sample No. 11 in Fig. 2; the critical current had its minimum value when the normal to the ribbon's surface was parallel to the field and its maximum value when this normal was at right angles to the field. Since, in the limit $H \to 0$, there was no preferred direction, the dependence on the field intensity lost its meaning. The same result was obtained in the limiting case $H \to H_c$ (Fig. 3).

Sample No.	Firing temperature, °C	Firing duration, hours	I_c, A at 14° K	
			$H = 0$	$H = 30$ kOe
Wire				
1	900	7	10.0	0.21
	950	8		
2	1000	7	3.2	0.02
	1050	8		
	1100	8		
3	900	13.5	3.3	0.12
4	900	40.5	3.0	0.20
5	900	40.5	2.0	0.15
Ribbon				
6—9	900	12.7	4	0.2
10	900	26.3	3.0	0.20
11	900	26.3	2.0	0.24
12	900	43		
	950	19.3	8.5	0.20
13	900	8		
	950	11.3	5.0	0.28
14	900	7	2.9	0.03
15	900	7	5.3	0.25

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[1] F. K. Lange, JETP **42**, 42 (1962), Soviet Phys. JETP **15**, 29 (1962).

[2] F. Lange, Monatsber. Deutschen Akad. Wiss. Berlin **6**, 294 (1964).

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