U. S. Department of Commerce
Malcolm Baldrige
Secretary
National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

REPORT OF INVESTIGATION

RESEARCH MATERIALS 8420 and 8421

Electrolytic Iron

Thermal Conductivity (λ) and Electrical Resistivity (ρ)

as a Function of Temperature from 2 to 1000 K

J. G. Hust and A. B. Lankford

These Research Materials (RM's) are for use in testing methods for measuring thermal conductivity and electrical resistivity. RM 8420 is available in rod form 0.64 cm in diameter and 5 cm long. RM 8421 is 3.17 cm in diameter and 5 cm long.

Measurements

A. Before 1979

Low-temperature (below ambient) characterization data consist of thermal conductivity, electrical resistivity, and thermopower measurements on one specimen; liquid helium and ice-point electrical resistivity measurements on about 20 specimens in various states of heat treatment;and other characterization data such as hardness, grain size, density, and composition [1]. The homogeneity of this electrolytic iron as determined from these data is excellent. The measurements indicate that the effect of material variability on thermal conductivity and electrical resistivity is no larger than $\pm$ 1%.

High temperature (above ambient) data presented by Fulkerson, et al, [2] on an iron similar to this electrolytic iron were used as a basis for the values above 300 K. The low temperature NBS data were correlated with the high-temperature data to produce smoothed values.

B. After 1979

These RM's were used in an international round-robin study of thermal and electrical properties under the auspices of the Task Group on Thermophysical Properties of CODATA (Committee on Data for Science and Technology). As a consequence of this cooperative program, a considerable quantity of new data and information were obtained. The additional work showed that (1) the RRR values obtained by the users were more variable than the results obtained earlier [1] and (2) slight revision in the values were indicated. Also,the new work provided a basis for extending the data to lower temperature.

Because of item (1) the values are dependent on the user-measured RRR according to the equation given in reference [3]. The values given in this report are for an RRR of 22.5.

The estimated uncertainties of the thermal conductivity data are 2% below and 3% above 280 K. The estimated uncertainties of the electrical resistivity data are 1% below and 2% above 280 K. The recommended values are corrected for thermal expansion.

The purity of this electrolytic iron is 99.90 wt.%. The density is 7.867 $\pm$ 0.005 g·cm^{-3}.

Gaithersburg, MD 20899
May 14, 1984

Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(over)

The data given below are for an electrical residual resistivity ratio, RRR, of 22.5. For other values of RRR see reference [3].

T(K)	$\lambda(W \cdot m^{-1} \cdot K^{-1})$	$\rho(n\Omega \cdot m)$	T(K)	$\lambda(W \cdot m^{-1} \cdot K^{-1})$	$\rho(n\Omega \cdot m)$
2	12.32	4.047	50	163.6	5.52
3	18.48	4.047	60	149.1	6.76
4	24.62	4.047	70	134.9	8.52
5	30.76	4.047	80	123.8	10.78
6	36.88	4.048	90	115.4	13.50
7	42.97	4.049	100	108.9	16.62
8	49.0	4.050	150	92.7	35.37
9	55.0	4.052	200	86.7	56.0
10	61.0	4.054	250	81.5	79.0
12	72.8	4.061	300	76.4	105.0
14	84.2	4.070	400	67.5	166.1
16	95.2	4.082	500	60.2	241.2
18	105.7	4.099	600	53.6	334.6
20	115.7	4.120	700	47.49	448.5
25	137.4	4.199	800	41.96	583.0
30	153.9	4.322	900	37.12	737.0
35	164.5	4.50	1000	32.98	909.0
40	169.1	4.75			
45	168.3	5.08			

[1] Hust, J.G., and Giarratano, P. J., Standard Reference Materials: Thermal Conductivity and Electrical Resistivity Standard Reference Materials: Electrolytic Iron, SRM's 734 and 797 from 4 to 1000 K, Nat. Bur. Stand. Special Publication 260-50 (1975).

[2] Fulkerson, W., Moore, J.P., and McElroy, D.L., Comparison of the Thermal Conductivity, Electrical Resistivity and Seebeck Coefficient of a High Purity Iron and an Armco Iron to 1000 °C, J. Appl. Phys. 37 No. 7, 2639-2653 (1966).

[3] Hust, J.G., and Lankford, A.B., Update of Thermal Conductivity and Electrical Resistivity of Electrolytic Iron, Tungsten, and Stainless Steel, Nat. Bur. Stand. Special Publication 260-90 (1984).