

National Bureau of Standards

REPORT OF INVESTIGATION

RESEARCH MATERIALS 8422 and 8423

Sintered Tungsten

Thermal Conductivity (λ) and Electrical Resistivity (ρ)

as a Function of Temperature (IPTS-68 and

NBS P2-20) from 2 to 3000 K

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These Research Materials (RM's) are for use in testing methods for measuring thermal conductivity and electrical resistivity. RM 8422 is available in rod form 0.32 cm in diameter and 5.0 cm long. RM 8423 is 0.64 cm in diameter and 5.0 cm long.

Measurements

A. Before 1979

Low-temperature (below ambient) characterization [1] consist of thermal conductivity, electrical resistivity, and thermopower measurements on two specimens of sintered tungsten. Liquid helium and ice-point electrical resistivity measurements were performed on several dozen specimens of sintered tungsten specimens in various heat treatment conditions. Other characterization data such as hardness, density, grain size, and composition were also obtained. These characterization data show that the effect of material variability on these properties can be in excess of 5% below 90 K. This uncertainty caused by material variability can be reduced to below 2% by measuring the residual resistivity ratio of the specimen. The effects of material variability at higher temperatures are within measurement uncertainty.

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 [3]. The values are changed by more than the stated uncertainty band below 60 K. The changes are appreciable above 2000K but within the stated uncertainty band.

The uncertainties of the data for thermal conductivity are 2% below 300 K and 2 to 5% from 300 to 3000 K. The uncertainties of the data for electrical resistivities are 2% over the entire temperature range.

These specimens have been annealed at 2300 K for one hour in vacuum. Details of the characterization measurements are presented in reference [1].

The density of the sintered tungsten is $19.23 \pm 0.05 \text{ g}\cdot\text{cm}^{-3}$.

Gaithersburg, MD 20899
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Stanley D. Rasberry, Chief
Office of Standard Reference Materials

(over)

The values given here are for RRR = 75. For other values of RRR see reference [3].

T(K)	$\lambda(\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1})$	$\rho(\text{n}\Omega\cdot\text{m})$	T(K)	$\lambda(\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1})$	$\rho(\text{n}\Omega\cdot\text{m})$
			100	213.4	10.95
2	74.7	0.654	150	194.9	21.87
3	112.0	.654	200	187.3	32.89
4	149.3	.654	250	180.9	44.08
5	186.4	.654	300	173.4	55.5
6	223.4	.655	400	157.5	79.3
7	260.0	.655	500	144.9	104.4
8	296.2	.655	600	136.2	130.9
9	331.8	.656	700	129.9	158.8
10	366.7	.657	800	125.2	187.8
12	434.0	.661	900	121.5	217.5
14	496.0	.666	1000	118.4	247.7
16	551.0	.674	1100	115.7	278.3
18	596.0	.686	1200	113.4	309.1
20	629.0	.701	1300	111.3	340.3
25	647.0	.766	1400	109.4	371.8
30	597.0	.879	1500	107.6	403.7
35	525.0	1.059	1600	106.0	436.0
40	454.5	1.322	1800	103.1	502.0
45	391.9	1.683	2000	100.6	569.0
50	339.0	2.148	2200	98.4	639.0
60	271.8	3.387	2400	96.5	709.0
70	244.0	4.98	2600	94.7	781.0
80	230.5	6.83	2800	93.1	855.0
90	220.9	8.85	3000	91.7	930.0

- [1] Hust, J.G., and Giarratano, P. J., Thermal Conductivity and Electrical Resistivity Standard Reference Materials: Tungsten, SRM's 730 and 799, from 4 to 3000 K, Nat. Bur. Stand. Special Publication 260-52 (1975).
- [2] Fitzer, E., Thermophysical Properties of Solid Materials Advisory Report 12 (1967); Advisory Report 38 (1972); Report 606 (1973), AGARD, NATO, France
- [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).