Physics. — *The change of the electric resistance of pure hafnium and zirconium between* 1.3° *K. and* 90° *K.* By W. J. DE HAAS and J. VOOGD. (Communication N°. 194*c* from the Physical Laboratory, Leiden).

(Communicated at the meeting of Nov. 24, 1928).

§ 1. In this communication we give the results of measurements of the electric resistance of pure hafnium and zirconium at temperatures between 1.3° K. and 90° K. We especially wished to find out, whether hafnium belongs to the supraconductive metals.

The electron configuration of the hafnium atom consists of completely occupied *K, L, M* and *N*-shells, an incompletely occupied *O*-shell and two valence electrons. The only difference in electron configuration from mercury is that in the hafnium atom the *O*-shell is less completely occupied than in the mercury atom.

The pure metals for these measurements were kindly put at our disposal by Dr. G. HOLST. We wish to express our thanks to Dr. J. H. DE BOER, who prepared these metals in a very pure state in the physical laboratory of PHILIPS' Electric Lamp Factory Ltd., Eindhoven.

§ 2. For the resistance measurements two spring-contact are fixed to both extremities of the wires. For this purpose we use flat *U*-shaped clamps of hard hammered brass. At the open side, where the contact with the wire had to be made, a piece of silver foil was soldered to the clamp in order to obtain an unoxidized contact-place. By the strong spring the clamp remained pressed against the wire even at the lowest temperatures.

During the measurements the contacts thus obtained proved to be good.

The resistances were measured in the usual way with the aid of a DIESSELHORST thermo-force-free compensation apparatus.

The temperatures were obtained in cryostats with baths of liquid helium, liquid hydrogen, and liquid oxygen.

§ 3. The resistances at 0° C. were determined before and after the measurements (table 1). For the specific resistance of hafnium we found 0.0000296. The accuracy of this determination was $\pm$ 2 %. The zirconium rod was too irregularly formed to have its specific resistance determined.

In table 2 give the values of $R/R_{0\,C.}$ of both wires at different temperatures.

TABLE 1.

	$R_{0°\,C.}$	
	Before the measurements	After the measurements
Hf	0.00864[2]	0.00866[7]
Zr	0.02659	0.02658

TABLE 2.

		Hf		*Zr*	
T			$R/R_{0°C.}$		$R/R_{0°C.}$
90.01			0.3045		0.2379
78.19			0.2626		0.1926
61.27			0.2039		0.1318
20.32			0.1000		0.0416[7]
18.00			0.0982		0.0403[9]
14.17			0.0963		0.0392[6]
	helium				
4.21	765 mm		0.0947		0.0383[2]
3.63	411 mm		0.0945		0.0383[6]
1.35	2.2 mm	100 mA	0.0947	100 mA	0.0383[6]
		30 mA	0.0949	30 mA	0.038[4]

In the figure the change of the resistances has been plotted graphically.

We draw attention to the fact, that also at low temperatures no minimum, as found before by KOENINGSBERGER and SCHILLING, occurs in the resistance-temperature curve of zirconium [1]). This was already established for higher temperatures by P. CLAUSING and G. MOUBIS [2]), who extended their measurements over a region from 297° K. to 98° K.

With hafnium also no minimum occurs.

[1]) Phys. Ztsch. **9** p. 347 (1908). Ann. d. Phys. **32**, p. 179 (1910).

[2]) „Physica", 1927 p. 245—250.

Further we found no sympton of supraconductivity in the temperature region investigated.

At the lowest temperature used, the resistances are independent of the

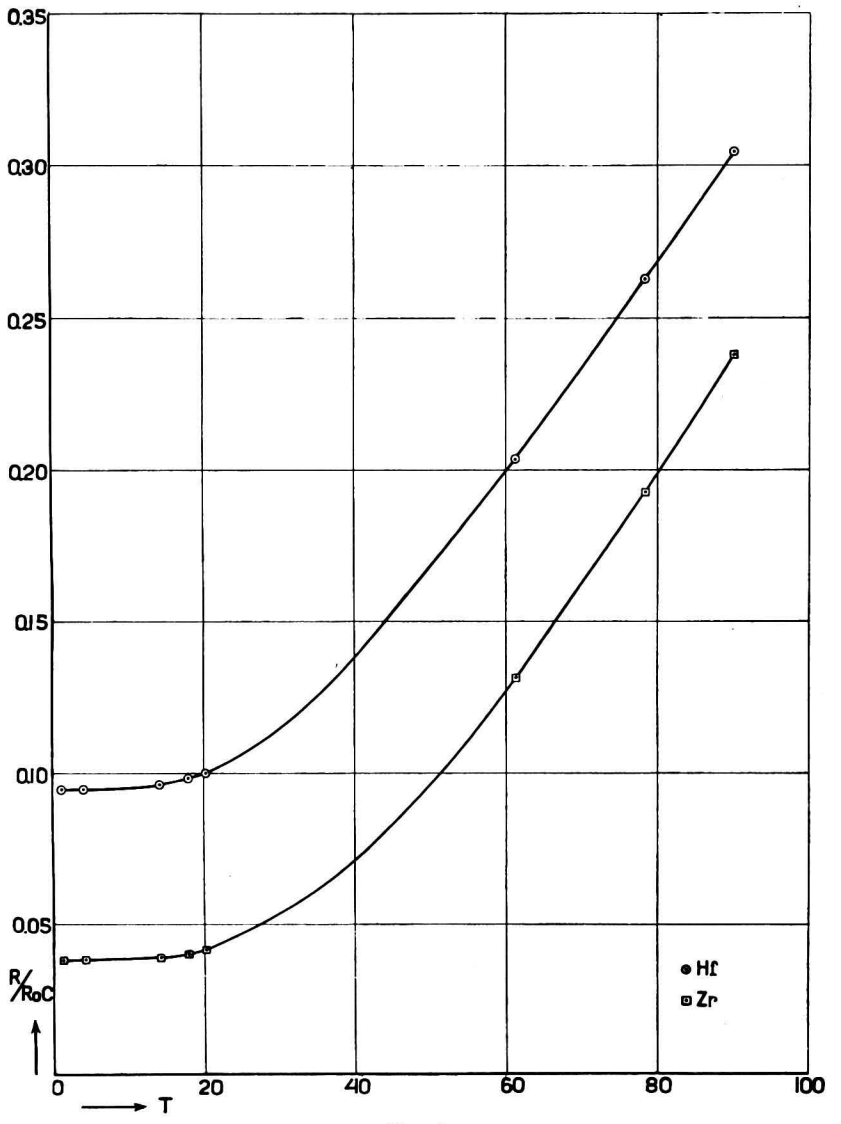

Fig. 1.

intensity of the measuring current, at least within the limits of accuracy.

From these experiments we may conclude, that hafnium and zirconium belong to the non-supraconductors, though of course we do not know what may happen at still lower temperatures.

Finally we express our thanks to Mr. J. D. RUTGERS VAN DER LOEFF for his kind assistance in the temperature measurements.