Absolute Thermoelectric Power of Chromium-Silicon Alloys (*) (**) 

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Summary. — The absolute thermoelectric power $S$ of chromium and chromium-silicon alloys containing 0.4%, 0.9%, 1.3%, 1.8%, 2.7%, 3.1% and 3.6% at. % silicon has been determined as a function of temperature $T$ between 50°C and 350°C. The $S$ vs. $T$ curves exhibit large anomalies in this temperature range due to the transition from a paramagnetic to an antiferromagnetic state. These transitions in samples containing 1.3%, 1.8% and 2.7% are essentially discontinuous and similar to that observed in the chromium-3.3 at. % iron sample at 248°C, where it undergoes a transformation from a transverse spin-density wave state to a commensurate antiferromagnetic structure. It is suggested that a commensurate antiferromagnetic structure also exists in the chromium-silicon system for silicon concentrations larger than 1 at. %.

1. — Introduction.

It is well known that metallic chromium below 313°C transforms into an antiferromagnetic state made up of spin-density waves. The onset of such a magnetic structure shows up very clearly in various transport properties. A few years ago we discovered (1), by means of electrical resistivity measurements on different chromium-rich chromium-silicon alloys, that the samples containing 1.3%, 1.8%, and 2.7% at. % silicon underwent very sharp transitions between 200 and 250°C. These anomalies in the electrical resistivity vs. temperature curves appeared to be quite different from those observed in the

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samples containing lower silicon concentrations. Furthermore, the sample with 1.3 at.% silicon also exhibited another small anomaly at about 110 °K. The detailed origin of these transitions is still not fully understood. Since, in general, the thermoelectric power is an even more sensitive function of electronic structure changes than electrical resistivity we decided to investigate this property in the chromium-silicon system as a function of temperature. The results and the importance of these measurements are described briefly in this paper.

2. - Experimental considerations.

The absolute thermoelectric power $S$ of chromium-silicon alloys containing 0.46, 0.9, 1.3, 1.8, 2.7, 3.1, and 3.6 at.% silicon was measured as a function of temperature $T$ between 50 and 350 °K. The same samples used in the previous electrical resistivity investigation were also utilized in the present study.

The thermoelectric power of the above-mentioned chromium-silicon alloys was determined using the differential method. The thermoelectric power cell is shown schematically in Fig. 1.

The sample $S$, usually in the form of a bar of dimensions $(4 \times 0.3 \times 0.3)$ cm$^3$, is mounted in the inner copper can $C_1$ which acts as a heat sink. This can is attached to the outer can $C_2$, also made of copper, by means of a short stainless steel tubing $T_1$ (o.d. $\frac{3}{8}$ in., wall 0.010 in.) which provides a high resistance thermal path between the two cans. Normally the chamber enclosed by this tubing is evacuated through another stainless steel tubing $T_2$ (o.d. $\frac{3}{16}$ in., wall 0.010 in.). Thus the inner can be conveniently kept, using a manganine heater $H_1$, above the temperature of the liquid (helium or nitrogen) surrounding the outer can $C_2$. If a better heat leak between the cans $C_1$ and $C_2$ is needed, the chamber enclosed by $T_1$ can be filled with gaseous helium. The can $C_1$ has a copper door (not shown in Fig. 1) which permits the sample to be placed inside the container. The door is thermally anchored by means of copper wires to the rest of the can $C_1$. The thermal conductivity cell can be evacuated through the stainless steel tubing $T_3$ (o.d. $\frac{3}{16}$ in., wall 0.016 in.) which is soldered in the copper lid. The outer can is attached to this lid and the cover assembly by means of a Wood’s metal seal $W$.

The temperature gradient along the sample $S$ is established using a heater $H_1$. It consists of noninductively wound quadruple-Formvar Manganin wire (No. 30, total resistance about 95 Ω at room temperature) on a light aluminum cap. This heater is soldered with indium to the sample. The other end of the sample is also soldered to a copper clamp $K$ which is fastened to the heat sink by means of two screws. The temperature difference along the sample is determined with copper-constantan and copper-gold with 0.07 at.%