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TRANSLATION

TO DETERMINE THE ENERGY OF FORMATION OF VACANCIES IN SILVER

By

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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

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To Determine the Energy of Formation of Vacancies in Silver

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O. M. Ovcharenko

The method of hardening (quenching) vacancies and measuring the increment in electro-resistivity is being widely used for studying the elementary act of self-diffusion in metals: gold [1-3], platinum [1, 4, 5], aluminum [6-8], copper [9]. In this experiment an effort was made to obtain data on the energy of formation and energy of activation in dislocation of vacancies (Q_1 and Q_2) in silver.

Samples for the investigations, were prepared from silver wire (99.99%) with a diameter of 0.05 mm and 100 mm in length. Relative values of residual resistivity ($\frac{R_{4,2°K}}{R_{20°C}}$, where $R_{4,2°K}$ - resistivity at a temperature of liquid helim, and $R_{20°C}$ - resistivity at room temperature) before the quenching was $1,3 \cdot 10^{-3}$. An ordinary method was used for quenching. [1]

The first experiments on quenching silver in open air showed that an increase in electro-resistivity originates not only as result of fixing the vacancies during the quenching but rather as result of detaining (delaying) the atoms by oxygen, which dissolves in silver when it is heated to high temperatures. Experiments were made on the quenching of silver in open air and in helium with varuous oxygen admixture concentrations.

table

See attachment, page 1a

In the table are given values $\frac{\Delta R}{R_{20°C}}$ (where ΔR - increase in resistivity due to quenching), which corresponds to a temperature of 1000°K in media with various oxygen

P, мм	$\sqrt{P}$, мм$^{\frac{1}{2}}$	$\frac{\Delta R}{R_{20^\circ}\,C} \cdot 10^3$	$\frac{\Delta R / R_{20^\circ}\,C}{\sqrt{P}}$, мм$^{\frac{1}{2}}$
175	13,24	13,6	1,0
3,2	1,79	1,5	1,2
1,3	1,14	0,9	1,2
0,06	0,22	0,1	0,5

Table

contents. It is evident, that with a reduction in the amount of the latter $\frac{\Delta R}{R_{20°C}}$ drops sharply.

The increase in resistivity at small content of admixture is proportional to its concentration (C). The concentration in turn, as is evident [11] is proportional to the square root of pressure (p). In this way the increase in resistivity should also be proportional to the root of p:

$$\frac{\Delta R}{R_{20°C}} \sim \sqrt{p}$$

It is evident from the table that $\frac{\Delta R}{R_{20°C}}$ decreases, like $\sqrt{p}$ at all pressure values with exception of the last one (p = 0.08 mm). This offers the possibility of making conclusions, that during the quenching of silver in air the increase in electrical resistivity is basically due to the fixation of the oxygen dissolved in silver. From the dependence of $\frac{\Delta R}{R_{20°C}}$ upon the quenching temperature which originated during heating in open air, was designated the energy of oxygen dillution in silver. It constitutes a value of 12000 cal/mol.

The increase in resistivity after the quenching of silver, when heated in pure helium (oxygen content $\leq$ 0.01%) is due basically to the detention of vacancies. The energy of formation is determined for this case and it amounts to 24000 cal/mol. This value is in perfect conformity with the values, obtained from measuring the increase in thermo-EMF in a pair of quenched-annealed metal during the heating of silver in the open air (23200 cal/mol [10]). Such a concurrence can be explained, apparently by the fact that the influence of oxygen on thermo EMF is not denoted, since it is present in annealed and quenched metals.

The energy of activation of the displacement of vacancies can be determined from kinetic curves of annealing. So far it was impossible to obtain such curves, because even in pure helium (oxygen content $\leq$ 0.01%) the oxygen during long lasting annealing was still capable of exerting a certain effect on the magnitude of electrical resistivity.

Experiments to quench silver in pure Aron are continuing.

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