THE INFLUENCE OF ALUMINIUM ADMIXTURE ON THE SUPERCONDUCTING PROPERTIES OF TIN*

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The variation of the superconducting properties of tin with different aluminium impurity concentration has been investigated. The measure of purity has been determined from the ratio $R_{300°K}/R_{4.2°K}$. It has been found that the transition temperature, the critical current, and the critical magnetic field depend on impurity concentration. The amount of alvminium soluble in tin does not exceed 0.7% at.

The superconducting properties of metals are strongly influenced by the number of electrons lattice constants, the electrical conductivity. By artificially putting foreign metal into the superconductor one can get a change of the superconducting properties of the specimen under investigation.

The concentration of the impurities may be calculated by knowing the mass of the admixture and that of the superconductor, or by applying a more exact method *i.e.* by measuring the electrical resistance at room and the boiling helium temperature. The ratio $R_{4.2°K}/R_{300°K}$ increases linearly.

With the concentration at least up to several percent of the admixture and it may be considered therefore as a relative measure of the specimen purity.

The change of the critical temperature and critical magnetic field with the ratio $R_{4.2°K}/R_{300°K}$ for tantalum has been discussed in our previous paper [1]. The same kind of investigation has been carried out for tin with aluminium impurities and the results are summarized in this paper. The samples were obtained by melting the pure tin in a high vacuum with an aopropriate percentage of pure aluminium and as the next step the allocy was melted again in a high vacuum in order to get specimens of cylindrical shape 2.5 mm in

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diameter and 10 cm long. In the final stage the specimens were maintened at a temperature of 220°C for three weeks in order to get complete homogenization.

The measurements of electrical resistance were performed at 300°K and 4.2°K (the boiling point of helium). The change of the ratio $R_{4.2^\circ K}/R_{300^\circ K}$ with concentration of aluminium in tin is depicted in Fig. 1. From the shape of the curve it is quite clear that solubility of aluminium in tin does nor exceed 0.7% at, for at this aluminium percentage

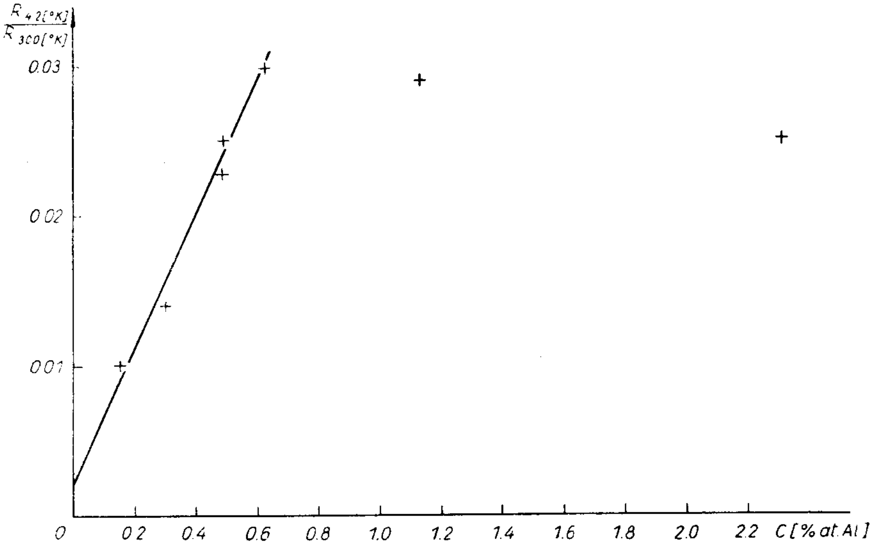

Fig. 1. The change of the electrical resistance with aluminium concentration in the tin

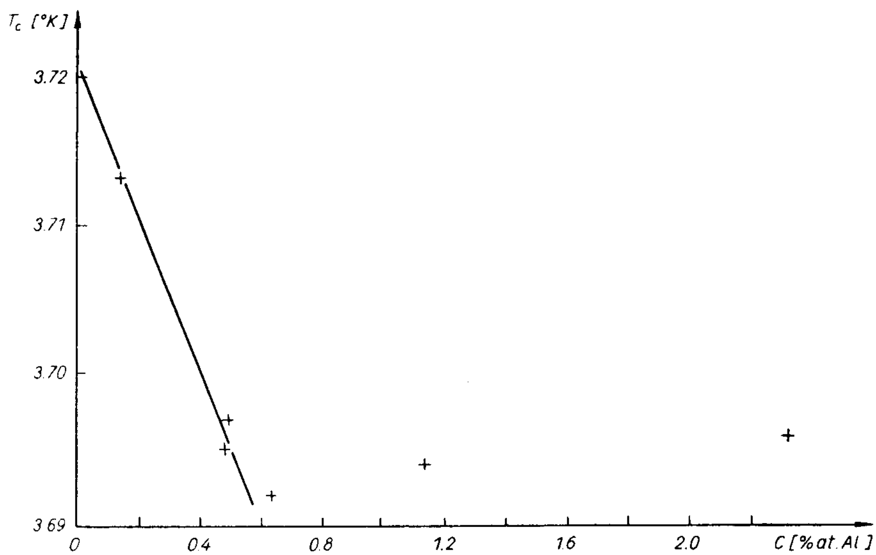

Fig. 2. The change of the transition temperature with aluminium concentration in the tin

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the resistance stops to increase. The transistion temperature T_c from the normal to the superconducting state has been estimated, from the electrical resistance measurements.

From the transition curves at the steady temperature the critical electric current has been estimated. By extrapolation of the straight line representing the change of the critical current intensity with temperature down to zero value of the current the critical temperature T_c has been obtained.

The change of T_c with the aluminium concentration c in tin has been depicted in Fig. 2. In the whole solubility region the transition temperature T_c decreases linearly with increasing concentration at the rate of

$$\frac{dT_c}{dc} = -0.052°\text{K}/1\%\ \text{at.}$$

From the above consideration one can conclude once more that the aluminium concentration does not exceed 0.7% at.

In Fig. 3 the change of T_c with the resistance ratio

$$\frac{R_{4.2°\text{K}}}{R_{300°\text{K}}}$$

is depicted.

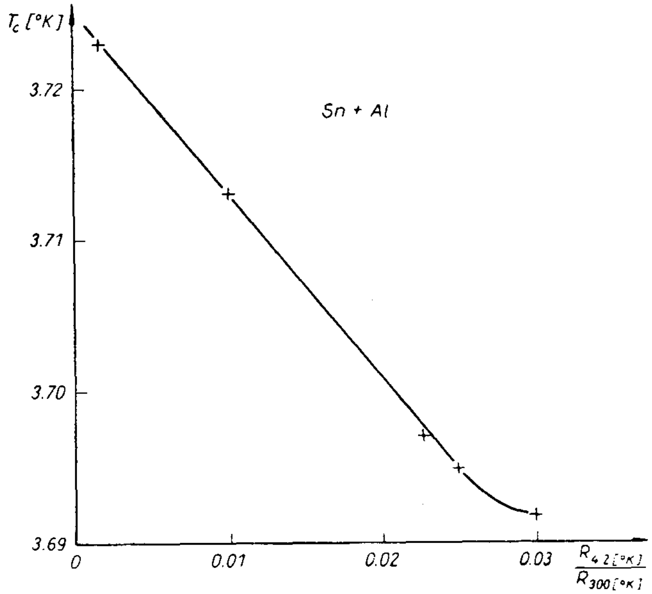

Fig. 3. The change of the transition temperature with the electrical resistance of the tin specimens with aluminium impurity

The change is at first linear exactly the same as in the case of tantalum [1].

The admixture of the foreign metal into the superconductor induces first of all a decrease of the mean free path of the electrons in low temperatures, hence interaction between the

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electrons and the lattice increases. As a consequence of this effect one could expect an increase of the transition temperature T_c.

On the other hand, the foreign atoms may induce disturbance of the lattice and this consequently lead to a decrease of T_c. The two effects may coincide and as the final result the transition temperature T_c decreases at first and afterwards increases with higher concentration of the impurities [2, 3].

For all specimens the critical magnetic field has been also investigated; it slightly increases with increasing percentage of aluminium in the tin.

The magnetization measurements showed that in all the specimens of tin with aluminium impurities there is a small hysteresis on the magnetization curve.

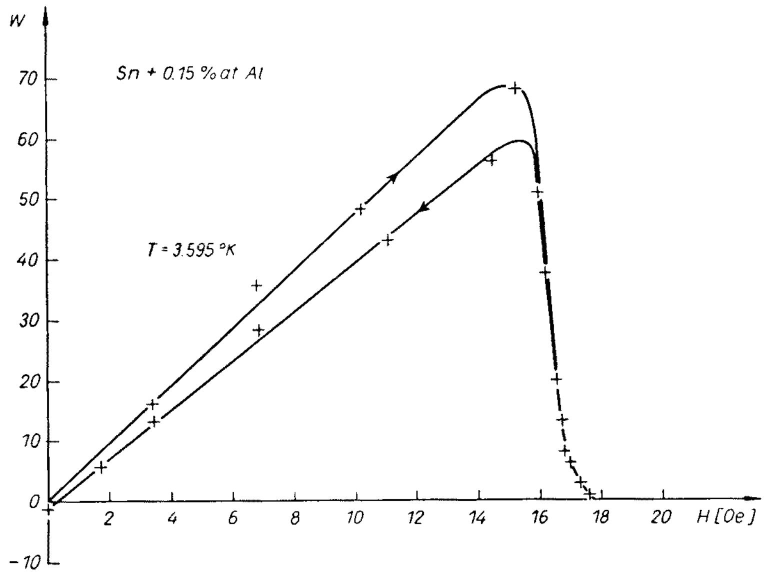

Fig. 4. The magnetization curve for the specimen Sn+0.15% at. Al. W — the deflection of the galvanometer, proportional to the magnetization

This effect is caused by inhomogenities in the internal structure of the specimens.

From the detailed analysis of all curves it may be concluded that the specimens were superconductors of the first class.

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