

$$i = \sigma (E + [\mathbf{v}B]), \quad (3)$$

in which  $E$  is the electric field. We perform the rot operation in both parts of (3) and use the facts that  $\text{rot } E = -\partial B/\partial t$  and that the magnetic field is stationary ( $\partial B/\partial t \equiv 0$ ) in a fixed frame of reference (as here); this gives

$$\text{rot } i = \sigma \text{rot } [\mathbf{v}B]. \quad (4)$$

But  $\text{rot}[\mathbf{v}B] \neq 0$ , so the current density in the tube is not zero. The current lines are closed in the horizontal walls of the tube (parallel to the  $xy$  plane), while the vertical walls (parallel to the  $xz$  plane) carry no current. Figure 2 shows a rough approximation for the current lines. The current in each wall is, of course, determined by the  $\Delta$  and  $\sigma$  of that wall. Arbitrary  $m$ ,  $\sigma$ , and  $\Delta$  will cause some of the current lines to encompass the whole tube; the distribution of the eddy currents cannot be found in any simple way, and the derivation of the magnetic field becomes much more complicated.

The assumptions they make, and hence the conclusions they obtain, are correct only when the potential difference per unit length along the  $y$  axis is exactly equal to the emf per unit length\*.

The system considered here satisfies this requirement if

$$\sigma_1 \Delta_1 = \sigma_2 \Delta_2, \quad m_1 = m_2$$

(this corresponds to Steidinger's case for  $d \rightarrow \infty$ , as they state) and if

$$\sigma_2 \Delta_2 \rightarrow \infty, \quad m_2 = 0, \quad d \rightarrow \infty.$$

Their solution is thus applicable only to these two particular cases.

5 May 1964

Krylov Central Research Institute

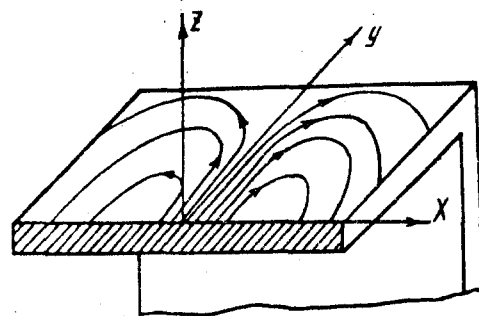


Fig. 2

## PHASE DIAGRAM FOR THE GaAs-Sn SYSTEM

A. P. Vasil'ev and A. P. Vyatkin

Izvestiya VUZ. Fizika, No. 3, pp. 152-153, 1965

Alloy junctions and ohmic contacts involve careful control of the depth of the melting. This depth can be calculated for Ge and Si (for a given temperature and weight of metal) from the phase diagram. Similar calculations for  $A^{III}B^V$  semiconductors are usually not possible on account of lack of phase diagrams. The GaAs-Sn diagram is very important in relation to p-n junctions in GaAs, because Sn is often used in ohmic contacts on n-type GaAs and in rectifying those on p-type GaAs.

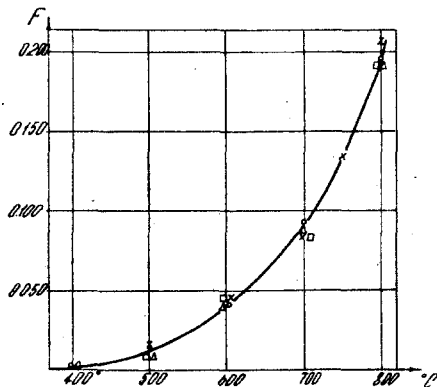


Fig. 1. Solubility  $F$  of GaAs in Sn as a function of temperature;  $F = v_1/v_2$ , where  $v_1$  is the volume of GaAs dissolving in a volume  $v_2$  of Sn.

Figure 1 gives our results [1] on the solubility of GaAs in Sn, which enables us to construct an approximate phase diagram for GaAs-Sn, which is of some interest, because it is difficult to construct the diagram directly from cooling curves on account of irreversible decomposition of GaAs, the equilibrium vapor pressure of As over this being very high [2].

The method of measuring the solubility has already been described [1] and was simply that a monocrystal of GaAs was placed in Sn heated to a given temperature and was left there until no more dissolved. The changes in weight were measured. The experiments were done in air at temperatures between the melting point of tin and  $800^\circ\text{C}$ , with precautions to prevent oxidation (a layer of activated charcoal).

\*The results of a previous paper by these authors (No. 4 of this journal for 1963) are not open to objection in that respect.

The phase diagram might have been supposed to contain a eutectic, which occurs for Ge-In, Ge-Ga, Ge-Sn, and so on [3]. Continuous solid solutions are unlikely in such systems on account of the large difference in the bond types. Liquid appears in the GaAs-Sn system in the range 210-255°C (somewhat below the melting point of tin), which confirms that there is a eutectic towards the tin-rich side.

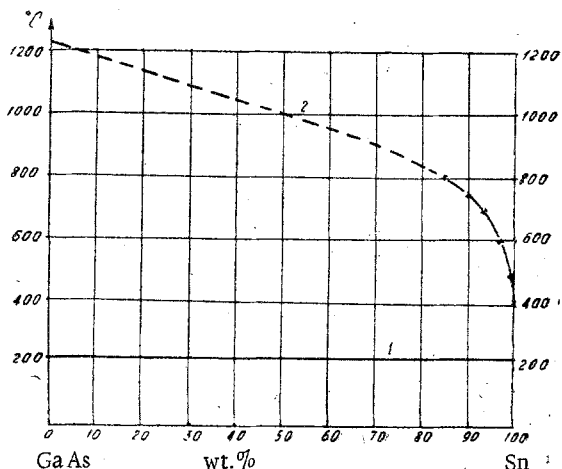


Fig. 2. Phase diagram of the GaAs-Sn system; the broken part of the curve is from extrapolation.

with the above value; extrapolation to the melting point of GaAs (1238°C) provides us with the liquidus in the phase diagram over a range not covered by experiment. This part is shown by the broken line in Fig. 2.

We are indebted to L. G. Lavrent'eva and A. P. Izvergin for valuable suggestions on this work.

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GaAs is only very slightly soluble in Sn below 400°C (Fig. 2), which is important to the production of Sn contacts of small depth on GaAs. The figure shows the liquids for the system, and it is clear that the eutectic is degenerate, because it lies very near pure Sn, as is very common in metal-semiconductor systems [3].

Metallography and radiography show that no new phases are produced in these contacts; the drop of melt after cooling contains only Sn mixed with GaAs, so the eutectic is between Sn and GaAs, not between any other compounds. The phase diagram of this quasibinary system may be said to be of type I, although the components may show only limited mutual solubility. This last parameter has not been measured, but the electrical activity of Sn in alloy contacts with GaAs indicates that GaAs dissolves no more than 1% Sn; a figure of 0.05 at.% at room temperature has been quoted [4]. Extrapolation of the solubility curve (Fig. 3) to low temperatures gives the Sn content of GaAs as 0.01%, which would agree

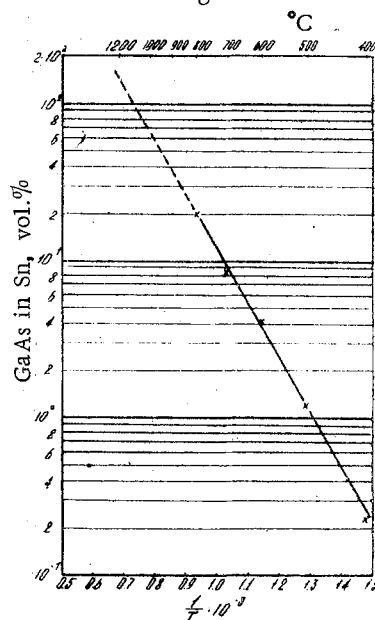


Fig. 3. Solubility as a function of T in the form  $\log F = f(1/T)$ .

23 April 1964

Kuznetsov Siberian Institute of Technical Physics

#### ON E. S. KAPLAN'S PAPER "PREFERRED USE OF THE INTERNATIONAL SYSTEM OF UNITS IN COURSES ON ELECTRICITY"

A. S. Tarnovskii

Izvestiya VUZ. Fizika, No. 3, p. 154, 1965

1. Kaplan incorrectly asserts that there is some connection between the system of units used and the basic views on the nature of electromagnetic phenomena. He claims that the CGS systems (including electrostatic and magnetic