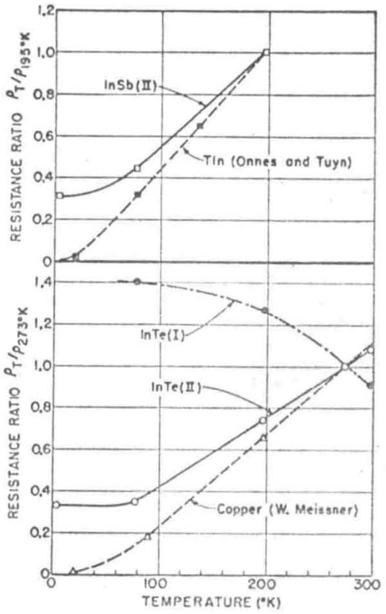

FIG. 2. Resistivity of InSb(II), InTe(I), and InTe(II) as a function of temperature.

the time which the sample was brought to this temperature. No change in resistance with time was detected at 77°K in an interval of two weeks. The resistivities of InSb(II) at 4.2 and 77°K were obtained on samples which were never above 77°K after their preparation at 25-kbar pressure. The resistivity ratio data are given in Fig. 2.

The higher electrical resistivity of InSb(II) in comparison with Sn(β) might be expected by analogy with alloys, notably silver and gold which form substitutional-type solid solutions from atoms of slightly different radii. The electrical resistivities of the intermediate solid solutions of silver and gold are higher than for the pure metals.[31] This increased resistivity is attributed to imperfection in the periodicity of the lattice of the solid solution.[32] The lattice parameters of InSb(II) are essentially identical with those of Sn(β). However, the atomic radii of In and Sb are probably slightly different from Sn. These differences in atomic radii of In and Sb would upset the periodicity in the InSb(II) structure and thus could account for the higher electrical resistivity of InSb(II) in comparison to Sn(β).

F. Velocity of Sound

The velocity of sound in polycrystalline InSb(II) is 3850 m/sec as compared to 3320 m/sec for polycrystalline metallic tin.[33]

The smaller compressibility and higher velocity of sound would suggest that InSb(II) has a higher Debye temperature than does Sn(β) in keeping with the greater hardness reported later.

V. METALLIC ALLOYS OF TIN AND INDIUM ANTIMONIDE

The similarities in structure of the semiconducting forms and of the metallic forms of indium antimonide and tin suggest that these two substances should be completely soluble in all proportions under conditions where both are in either their (a) semiconducting states or (b) metallic states. It is known that metallic tin is insoluble in InSb(I).[34] However, conditions of pressure and temperature at which the metallic and nonmetallic forms of tin and indium antimonide are stable are greatly different.

We now report that tin and indium antimonide form metallic alloys from liquid solutions solidified at pressures where InSb(II) is the thermodynamically favored phase. Such alloys have been obtained in a metastable state at atmospheric pressure by quenching them to −196°C, then reducing the pressure at this low temperature. It appears that a continuous series of solid solutions must exist.

Preparation: Metallic alloys InSbSn, $InSbSn_2$, and $InSbSn_4$ were prepared in the following manner: The elements In, Sn, and Sb each of 99.995% purity were melted and thoroughly mixed in an evacuated silica tube. The solution was then cooled rapidly to room temperature. This yielded a finely divided mixture of Sn(β) and InSb(I). This mixture was transferred to a boron nitride container, compressed to 30-kbar pressure at 24°C then heated to 600°C. Each sample was kept at this pressure and temperature for one hour and then cooled slowly to −196°C. The pressure then was reduced to 1 atm and the sample removed from the apparatus—all at a temperature of −196°C.

These metallic alloys show an increase in thermal stability as the tin content is increased. InSb(II) reverts explosively to InSb(I) when the temperature is raised to −65°C. The metallic alloy InSbSn transforms slowly (hours) at room temperature with transformation becoming essentially complete in one minute at 45°C. The rates of conversion of $InSbSn_2$ and $InSbSn_4$ are slower and occur at even higher temperatures. (These data in themselves essentially prove that solid solutions have been formed.)

The lattice spacings for Sn(β), InSb(II), and the metallic alloys InSbSn, $InSbSn_2$, and $InSbSn_4$ were obtained from x-ray diffraction measurements using the Braggs-Brentano method (Cu $K\alpha$ x radiation) at atmospheric pressure. At 25°C the lattice parameters (of Table I) of $InSbSn_4$ and $InSbSn_2$ and Sn(β) at 25°C are in good agreement with those given by Swanson and Tatge.[27] Likewise the lattice parameters of InSbSn and InSb(II) are not significantly different from Sn(β) at −196°C.

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