section) provides experimental proof of this contention. SnAs with the NaCl-type structure and valence formula $Sn_{0.5}^{2+}Sn_{0.5}^{4+}As^{3-}$, has very nearly the same T_c as InTe with valence formula $In_{0.5}^{+}In_{0.5}^{3+}Te^{2-}$. Each has the same number of carriers per formula unit (although the carrier concentration of SnAs is somewhat higher than that of InTe because its lattice constant is smaller than that of InTe). The pressure-induced phase with stoichiometric formula In_3Te_4 (see following section) has the anti-Sn_4As_3 structure[10] which is related to the NaCl-type structure. The ionic model applied to this phase indicates that $2\frac{1}{2}$ In^{3+} and $\frac{1}{2}$ In^+ ions are required to balance the 4 Te valencies and there is one carrier per formula unit; for electrostatic balance, Sn_4As_3 requires $3\frac{1}{2}$ Sn^{2+} and $\frac{1}{2}$ Sn^{4+} ions. The superconducting transition temperatures of In_3Te_4 and Sn_4As_3 are respectively $1.25–1.15°K$ and $1.19–1.16°K$. Because SnAs and InTe have about the same carrier concentrations, and the same T_c's, it would be logical to conclude that Sn_4As_3 and In_3Te_4 with very nearly the same T_c's should have very nearly the same carrier concentrations. Thus, In Sn_4As_3 the number of Sn^{4+} ions must determine the number of carriers per formula unit, which is again one. Thus for consistency, when the lower valence ions are in excess, the number of carriers is determined by the number of higher valence cations, and when the higher valence cations are in excess, the number of carriers is determined by the number of lower valence cations.

The normalized formula for an In-rich compound with NaCl-type structure is

$$In(Te_{2/(2+x)}In_{x/(2+x)}).$$
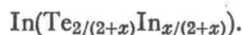
If it is assumed that all In atoms are ionic, we would have

$$y + 3\left(1 + \frac{x}{2+x} - y\right) = \frac{4}{2+x},$$

from which

$$y = (1 + 3x)/(2 + x)$$

and

$$1 + \frac{x}{2+x} - y = (1 - 2x)/(2 + x)$$

which is the number of trivalent ions per formula unit. A plot of T_c (midpoints) vs. n for both sides is

shown in Fig. 2; the agreement is seen to be good. The maximum T_c occurs (within experimental error) for stoichiometric InTe which has maximum n.
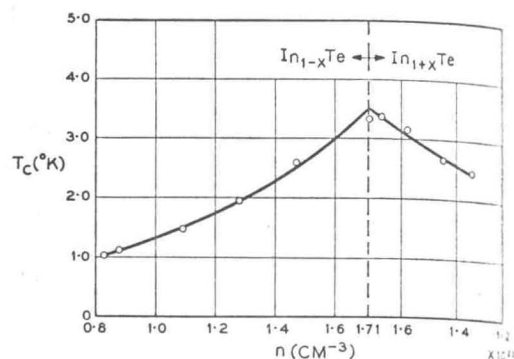

FIG. 2. Superconducting transition temperature, T_c, vs. carrier concentration, n.

We have shown[2] that, as predicted, substitution of Ag^+ for In^+ or As^{3-} for Te^{2-} resulted in a decrease of T_c. Both substitutions cause a decrease in n, the Ag^+ for In^+ because the Ag $4d$ electrons are tightly bound to it and As^{3-} for Te^{2-} by increasing the number of In^{3+} (thereby decreasing the number of In^+ ions) needed for electrostatic balance. However, in these systems, the carrier concentrations required for a given T_c is always somewhat higher than required in the $In_{1-x}Te$ system. It may be speculated that this results from scattering by intervening In^{3+} ions which are 'inactive' because they are paired with Ag^+ or As^{3-} ions. (See also Ref. 2.)

CRYSTAL STRUCTURE OF THE PRESSURE INDUCED In_3Te_4 PHASE

Weissenberg ($CuK\alpha$ radiation) and Buerger precession camera ($MoK\alpha$ radiation) photographs were taken of a single crystal fragment isolated from a run in which an attempt was made to grow a single crystal of the high pressure In_2Te_3 phase. The diffraction symmetry of the combined photographic data is $R\bar{3}m$; with no systematic absences, the possible space groups are $R\bar{3}m – D_{3d}^5$ and $R3m – C_{3v}^5$. The hexagonal axes as determined from the precession camera photographs are $a = 4.27 \pm 0.01$, $c = 40.9 \pm 0.1$ Å; the rhombohedral lattice constants derived from these are $a = 13.8_5$ Å, $\alpha = 17.7_3°$.