Preliminary Note on the Phase Relationships in the NickelTin System

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Because of the great industrial importance of the bronzes the constitutional diagram of the copper-tin alloys has been the subject of a large number of investigations. In the so-called nickel bronzes which are ternary alloys of copper, nickel and tin, the phenomenon of precipitation hardening is observed in certain ranges of composition. A knowledge of the phase relationships in the binary system nickel-tin is essential for the understanding of this phenomenon. It is therefore somewhat surprising that no complete x-ray investigation has as yet appeared in the international literature.

In connection with an investigation of the nickel bronzes we have made a complete examination of the nickel-tin system by x-ray methods. Because of its general interest we are communicating a brief summary of the more important phase relationships in what follows. A complete discription of our methods and results will appear in a later publication. Our results differ considerably from the results of earlier investigators who used the methods of thermal analysis and microscopic examination.

1. The investigation of the Ni-Sn system has been extended beyond the solubility limit of Sn in Ni already reported by the authors.[1]

2. The next phase to the nickel solid solution phase occurs at the composition Ni_3Sn. This phase has a very narrow composition range.

3. The Ni_3Sn phase is in equilibrium with a phase having a typical nickel arsenide structure between approximately 25.0 and 37.5 atomic percent tin.

4. The nickel arsenide structure first appears alone at about 37.5 atomic percent Sn but extends as a homogeneous phase only up to 45 atomic percent Sn. It thus requires excess nickel atoms to stabilize the lattice.

5. At 40 atomic percent Sn or the composition Ni_3Sn_2, a new phase forms from the nickel arsenide-like phase at temperatures below 500°C. Its diffraction pattern appears to be closely related to the nickel arsenide structure and it may be a deformed modification. The range of homogeneity must be quite small since it is not found at 38.0 nor at 42.5 atomic percent Sn.

6. The homogeneity range of the NiAs-structure is independent of temperature on the high tin side but increases slightly at higher temperatures on the high nickel side.

7. In the remainder of the system there are three new phases provisionally called eta, theta and zeta. The first two have very narrow homogeneity ranges at approximately 51 and 54 atomic percent Sn, respectively. The eta phase forms by a peritectoid reaction between the NiAs-structure and theta. The zeta phase extends between approximately 56 and 62 atomic percent Sn although this range may possibly be more complicated.

8. The zeta phase coexists with the tin phase from 62 percent up to practically 100 percent Sn. The diffraction patterns indicate that the solubility of nickel in tin is very low

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[1] E. R. Jette and E. Fetz, Metallwirtschaft **14**, 165 (1935).