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Effect of Pressure on the Resistivity of Ag–Au Alloys[1])

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The effect of pressure on the resistivity of $Ag_{1-c}Au_c$ solid solutions has been measured up to 4 kbar in the temperature range 4 to 273 °K. Solid and fluid helium were used as the pressure transmitting media. The pressure derivatives of the total resistivity, $\varrho^{-1}\,\mathrm{d}\varrho/\mathrm{d}P$, for the alloys in the concentration range $c = 0.1$ to 0.9 were observed to be negative and to increase in magnitude with increasing temperature. It is shown that the magnitude and sign of $\varrho^{-1}\,\mathrm{d}\varrho/\mathrm{d}P$ is primarily determined by the pressure derivative of the residual resistivity. The volume derivative of the residual resistivity, $\mathrm{d}\ln\varrho_0/\mathrm{d}\ln V$, was found to be positive and concentration dependent. It is suggested that the influence of the filled d-bands on the scattering potential is responsible for the behavior of $\mathrm{d}\ln\varrho_0/\mathrm{d}\ln V$.

Der Einfluß von Druck auf den spezifischen Widerstand von $Ag_{1-c}Au_c$-Mischkristallen wurde bis 4 kbar im Temperaturbereich von 4 bis 273 °K gemessen. Als Druckübertragungsmittel wurde festes bzw. flüssiges Helium verwendet. Es wurde festgestellt, daß die Druckableitungen des Gesamtwiderstands, $\varrho^{-1}\,\mathrm{d}\varrho/\mathrm{d}P$, für die Legierungen im Konzentrationsbereich $c = 0{,}1$ bis 0,9 negativ sind und mit steigender Temperatur zunehmen. Es wird gezeigt, daß Größe und Vorzeichen von $\varrho^{-1}\,\mathrm{d}\varrho/\mathrm{d}P$ vorwiegend durch die Druckableitung des spezifischen Restwiderstands bestimmt werden. Die Volumenableitung des spezifischen Restwiderstands $\mathrm{d}\ln\varrho_0/\mathrm{d}\ln V$ ist positiv und konzentrationsabhängig. Es wird vorgeschlagen, daß der von den vollbesetzten d-Bändern auf das Streupotential ausgeübte Einfluß für das Verhalten von $\mathrm{d}\ln\varrho_0/\mathrm{d}\ln V$ verantwortlich ist.

1. Introduction

The effect of pressure on the electrical resistance of many elements and alloys has been studied in detail in the vicinity of ambient temperatures. There have been considerably fewer studies made at low temperatures because of the problems associated with generating nearly hydrostatic pressures. The low temperature region, however, is the most interesting because the lattice resistance is the most sensitive to temperature and pressure in this region and because the effects of alloying can be studied directly at 4 °K. Dugdale [1] has measured the temperature dependence of the pressure derivative of the lattice resistivity, $\varrho_l^{-1}\,\mathrm{d}\varrho_l/\mathrm{d}P$, for the alkali metals and Cu from 4 to 300 °K using solid and fluid helium as the pressure transmitting media. Similar measurements on Ag, Au, Sn, and In were reported by Goree and Scott [2]. These authors found that $\varrho_l^{-1}\,\mathrm{d}\varrho_l/\mathrm{d}P$ becomes large and negative at low temperatures in fair agreement with the Bloch-Grüneisen theory.

A few studies have been made on the effect of pressure on the residual resistivity of dilute alloys by direct measurement at 4 °K; however, there has been no work done on concentrated alloys. Dugdale [3] has measured the volume derivative of the residual resistivity, $\mathrm{d}\ln\varrho_0/\mathrm{d}\ln V$, for dilute noble metal alloys containing homovalent and heterovalent impurities. He suggests from

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