

Fig. 2. Typical resistance versus pressure isotherms for the 25 at% Au-75 at% Ag alloy.  $\circ$  indicates increasing pressure and  $\triangle$  indicates decreasing pressure

to measure all voltages. Coarse temperature control was effected by positioning the pressure bomb in the vapor just above the liquid bath and fine control ( $\pm 0.05$  °K) was accomplished with a Cryogenics Research model TC 101 controller. Below 30 °K temperature was measured within  $\pm 0.05$  °K using a Cu-AuFe thermocouple. Above 30 °K temperature was measured to within  $\pm 0.5$  °K using a Cu-constantan thermocouple.

The resistance data were taken as a function of pressure at various constant temperatures. Typical isotherms are shown in Fig. 2 for the  $c = 0.25$  alloy. The resistance data were taken with both increasing and decreasing pressure to insure that the sample had not been strained and that the temperature remained stable during the run. Several runs at the same temperature indicated that the initial pressure derivative,  $R^{-1} dR/dP$ , could be determined to within  $\pm 0.05 \times 10^{-3}$  kbar $^{-1}$ .

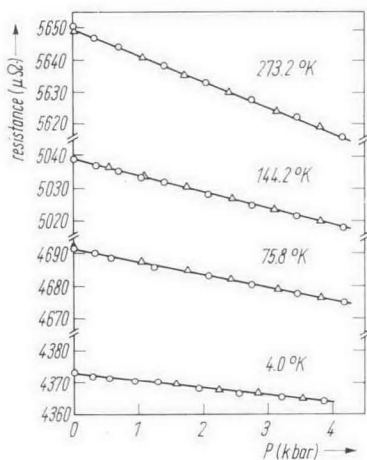
To compare the experimental results with theory the pressure derivative of the resistance must be measured at a constant volume,  $V_0$  (usually taken as the volume of the sample at 0 °K). For  $T > 0$  °K the volume,  $V(T)$ , is calculated from the thermal expansion and the pressure,  $P'$ , required to compress the sample back to  $V_0$  is calculated from the compressibility. The constant volume pressure derivative,  $R'^{-1} dR'/dP$ , is the pressure derivative measured at  $P'$ , and for the  $Ag_{1-c}Au_c$  alloys at 298 °K,  $P' \approx 10$  to 12 kbar. The resistance of the  $c = 0.25$  alloy was measured as a function of pressure up to 20 kbar at 298 °K in a high pressure liquid pentane press. The constant volume pressure derivative  $R'^{-1} dR'/dP$  (measured at 12 kbar) was found to be 9% less than  $R^{-1} dR/dP$  (measured at 1 bar). For  $T < 200$  °K the difference between  $R'^{-1} dR'/dP$  and  $R^{-1} dR/dP$  was found to be within the experimental error. To convert from resistance to resistivity the following expression is used to account for the pressure dependence of the geometrical factor

$$\frac{1}{\rho} \frac{d\rho}{dP} = \frac{1}{R'} \frac{dR'}{dP} - \frac{\chi(T)}{3}, \quad (1)$$

where  $\chi(T)$  is the compressibility at  $T$ . The compressibility of the alloys was obtained by extrapolating between the values for pure Ag and Au [5 to 7].

### 3. Results

The measured initial pressure derivative,  $R^{-1} dR/dP$ , as a function of temperature for three of the alloys is shown in Fig. 3. For these alloys  $R^{-1} dR/dP$  is observed to increase smoothly with decreasing temperature ( $\approx -1.4 \times 10^{-3}$  kbar $^{-1}$  at 273 °K to  $\approx -0.7 \times 10^{-3}$  kbar $^{-1}$  at 4 °K). In the case of pure



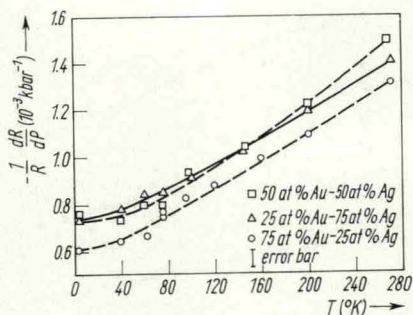


Fig. 3. The temperature dependence of the measured pressure derivative of the resistance for three typical alloys

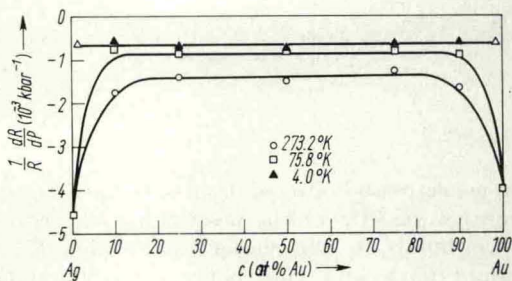


Fig. 4. The concentration dependence of the measured pressure derivative of the resistance.  $\Delta$  indicates Dugdale's data for dilute alloys [3]

Ag and Au the pressure derivative of the lattice resistance decreases with decreasing temperature ( $\approx -4.5 \times 10^{-3}$  kbar $^{-1}$  at 273 °K to  $\approx -20 \times 10^{-3}$  kbar $^{-1}$  at 4 °K). The weak temperature dependence of  $R^{-1} dR/dP$  for the alloys as compared to Ag and Au indicates that disorder scattering strongly influences the behavior of  $R^{-1} dR/dP$  for the alloys.

In Fig. 4,  $R^{-1} dR/dP$  is plotted as a function of concentration for the three bath temperatures. It is observed that  $R^{-1} dR/dP$  is relatively insensitive to concentration from  $c = 0.1$  to 0.9 as compared to the concentration dependence of the resistance. This is to be expected because the disorder resistance is proportional mainly to the number of deviations from periodicity of the lattice potential and is effectively divided out in the pressure derivative,  $R^{-1} dR/dP$ . It should be pointed out that the constant volume pressure derivative,  $R'^{-1} dR'/dP$ , has nearly the same temperature and concentration dependence as  $R^{-1} dR/dP$  as shown in Fig. 3 and 4, except that the 273 °K points would be decreased in magnitude by  $\approx 9\%$ .

The pressure derivative of the residual resistance is taken to be the measured pressure derivative at 4 °K. This is justified in Section 4 following the discussion on Matthiessen's rule. The pressure derivative of the residual resistivity,  $\varrho_0^{-1} d\varrho_0/dP$ , was calculated from the raw data by using equation (1) and the volume derivative of the residual resistivity,  $d \ln \varrho_0/d \ln V$ , was obtained by multiplying  $\varrho_0^{-1} d\varrho_0/dP$  by  $-\chi^{-1}$ . The results are shown in Table 1. It is observed

Table 1  
Volume and pressure derivatives of the residual resistivity as a function of concentration

$c$ (at % Au)	$\varrho_0^{-1} d\varrho_0/dP$ ( $10^{-3}$ kbar $^{-1}$ )	$d \ln \varrho_0/d \ln V$
$\approx 1$		1.00*)
10	-0.892	1.01
25	-1.016	1.22
50	-1.014	1.38
75	-0.832	1.29
90	-0.739	1.25
$\approx 99$		1.20*)

\*) Dugdale [3].