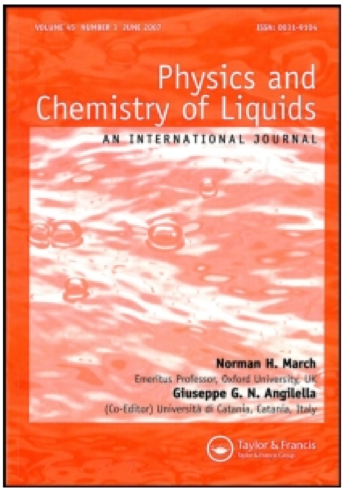

Physics and Chemistry of Liquids
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713646857

Magnetic suspectibilities of liquid gold alloys

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To cite this Article Tsuchiya, Yoshlc and Tamaki, Shigeru(1974) 'Magnetic suspectibilities of liquid gold alloys', Physics and Chemistry of Liquids, 4: 2, 157 — 161
To link to this Article: DOI: 10.1080/00319107408084281
URL: http://dx.doi.org/10.1080/00319107408084281

Phys. Chem. Liq., 1974, pp. 157-161

Printed in Dordrecht, Holland

Magnetic Suspectibilities of Liquid Gold Alloys

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(*Received June 19, 1973*)

The temperature dependences of the magnetic susceptibilities of liquid Au-Zn and Au-Cd alloys have been measured. Curves of the susceptibilities of these alloys for all concentrations show rather a big deviation from the linearly interpolated ones. With the increase of temperature, these curves approach the interpolated curves. This fact might be related to the change of clustering in the liquid state, which approaches a random mixture with the increase in temperature.

1. INTRODUCTION

The magnetic susceptibilities of most simple liquid metals and their alloys can be interpreted by the nearly free electron approximation (Wilson 1965) and possibly the susceptibility of an alloy might be close to the value linearly interpolated between those of its two components. However, some liquid alloys do not belong to the above category if they tend to form clusters resembling compounds.

The thermodynamical data, such as the heat of mixing and the excess free energy and density of liquid noble metal alloys, show large deviations from the interpolated mean values of those of host metals (Hultgren, Orr, Anderson and Kelly 1963). The formation of some clusters is involved in these alloys. Nevertheless, the electronic properties of these alloys can often be interpreted in terms

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of the NFE picture. E.g., Enderby and Howe (1968) have measured the thermoelectric powers of liquid Cu-Sn system and have shown that these obey the NFE approximation.

It is not very clear why the electronic properties of these noble metal alloys can be interpreted by NFE theory though their thermodynamical data are rather different from simple mixtures. At this point, more detailed data to reconcile this approvent conflict are required.

From the thermodynamical data, the liquid Au-Zn and Au-Cd systems have some tendency to form clusters related to intermetallic compounds in the solid state. We have measured the magnetic susceptibilities of these liquid systems in order to see how the clustering affects the susceptibility.

2. EXPERIMENTAL PROCEDURE

The specimens Au-Zn and Au-Cd alloys were prepared in silica crucibles which were sealed in vacuum. The purities of host metals were both 99.999%.

The susceptibility measurement was done with a torsion balance. The feedback current required to cancel out the torsion acting on a specimen in a magnetic field was recorded. The field strength of the magnet was 6500 Gauss with a pole gap of 5 cm. The silicon carbide furnace used in the present experiment raised the specimen temperature to 950°C. Purified Mohr's salt was used as a standard sample.

3. EXPERIMENTAL RESULTS AND DISCUSSION

The temperature dependences of the magnetic susceptibilities of $Au_{0.5}Zn_{0.5}$ and $Au_{0.5}Cd_{0.5}$ in the solid and liquid state are shown in Figures 1 and 2 and are small the solid state. The differences between the susceptibilities in these solid and liquid alloys at the melting point are $1.8 \cdot 10^{-8}$ for $Au_{0.5}Zn_{0.5}$ and $1.2 \cdot 10^{-8}$ C. G. S. e. m. u. for $Au_{0.5}Cd_{0.5}$, respectively.

In these alloys, the temperature dependences of susceptibility in the liquid state are rather larger than those in the solid state.

In Figures 3 and 4, the temperature dependences of the magnetic susceptibilities of Au-Zn and Au-Cd alloys in their liquid state are shown. These temperature dependences are nearly linear. Using these results and the diamagnetic susceptibilities calculated by Hurd and Coodin (1967), the iso-thermal electron susceptibilities $\chi el/mol$ are plotted against the compositions in Figures 5 and 6. In these figures, the dashed curves are derived from linearly interpolated values. deviation is the greatest at the composition of 50-50 at % in both cases. The From these figures, we can see a deviation from the interpolated values. The

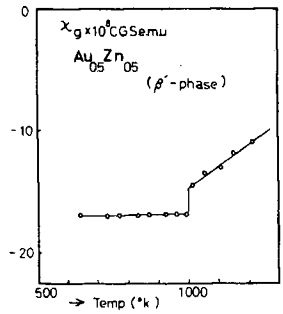

FIGURE 1 Temperature dependences of the susceptibilities of β'-AuZn in the solid and the liquid states.

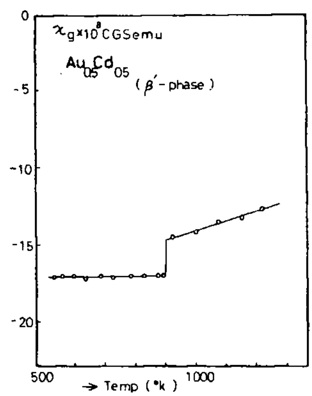

FIGURE 2 Temperature dependences of the susceptibilities of β'-AuCd in the solid and the liquid states.

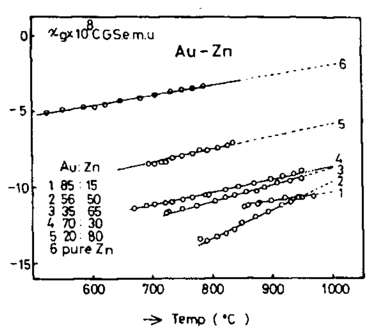

FIGURE 3 Temperature dependences of the susceptibilities of Au-Zn system in the liquid state.

temperature dependences of the susceptibilities are also greatest at the same composition.

As mentioned before, the thermodynamical data in these alloys have shown some cluster formation.

The difference between the magnetic susceptibilities of solid and liquid $Au_{0.5}Zn_{0.5}$ and $Au_{0.5}Cd_{0.5}$ alloys at their melting points are very small. This fact can be understood if we suppose that the β'-phase structure remains in the liquid state.

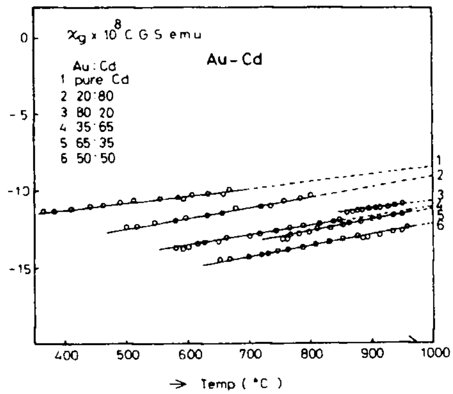

FIGURE 4 Temperature dependences of the susceptibilities of Au-Cd system in the liquid state.

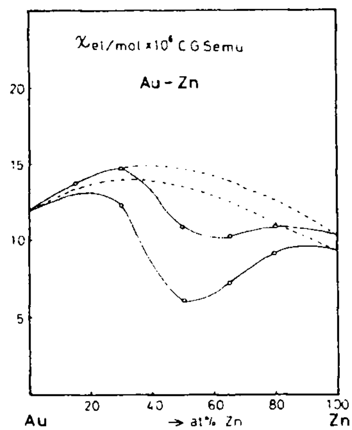

FIGURE 5 Concentration dependences of the electron susceptibilities of Au-Zn system in the liquid state.
______ ______________ observed values, ... interpolated mean values.

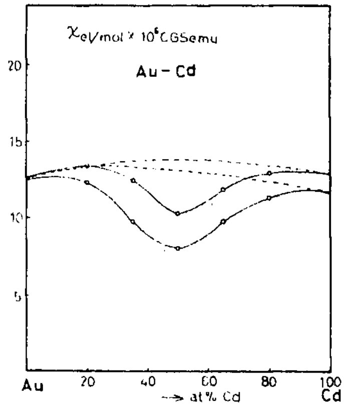

FIGURE 6 Concentration dependences of the electron susceptibilities of Au-Cd system in the liquid state.
——————— observed values, - - - - - - - - - - - - - - interpolated mean values.

In the liquid Ay-Zn and Au-Cd alloy systems, the deviation of the susceptibility for all concentrations from the curve of the interpolated mean values approaches their mean values with increase in temperatures. This fact seems to correspond to a decrease in the clustering.

In the liquid state of these alloy systems, some portion retains its compound formation and the other is random mixture, like an alloy which, above its order-disorder transition temperature, still retains some short range order.

If the residual clustering in the liquid state is similar to β'-phase alloy, a small amount of it may still make a quite large negative contribution to the magnetic susceptibility. Thus, the magnetic susceptibility would have a large deviation from the interpolated curve even though the transport properties are explained by NFE picture appropriate to the randomly mixed part.

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