Properties of Palladium–Rhodium Alloys

An earlier communication[1] from these laboratories gave preliminary results of an investigation into the magnetic susceptibilities of a series of palladium–rhodium alloys. A noteworthy finding was that alloying palladium with an element, rhodium, of a much lower susceptibility could, over a limited concentration-range, produce alloys having susceptibilities higher than those of either of the pure metals. This was more noticeable at low temperatures. More detailed investigations, since completed, have confirmed the general correctness of these results although minor adjustments of the absolute values previously given are required in some cases.

In addition to this more extensive investigation covering the magnetic properties of a range of alloys and pure metals, the low-temperature specific heats of four palladium–rhodium alloys have now been measured. The values of γ, the electronic heat coefficient, as obtained from measurements below 4·2° K., are shown as functions of the alloying metal content in Fig. 1. A few results for palladium–silver alloys[2] are also included to indicate the general trend of the curve on alloying with the element of next higher atomic number. For comparison the susceptibility–concentration curves have been drawn for palladium–rhodium and palladium–silver alloys at temperatures of 20·4° and 293° K.

The initial rise in the value of γ above that of pure palladium for small additions of rhodium, followed by the subsequent decrease as the rhodium content increases, is similar to the behaviour shown by the magnetic susceptibility, χ. It would be more illuminating to compare the γ values with the susceptibility values at 0° K.; this would, however, necessitate extrapolating downwards from 20·4° K. In view of the large curvature of some of the susceptibility–temperature curves at low temperatures it has not been considered justifiable to do this.

Although various explanations of the facts here reported are possible it is appropriate in this communication to refer only to the straightforward and consistent qualitative picture provided by the simple band theory, according to which the addition of rhodium creates more holes in the *d*-band while the addition of silver has the contrary effect. This interpretation does not, in its usual form, give a quantitative explanation of the results here presented. In particular, there is difficulty in reconciling the much larger relative increase in susceptibility at low temperatures with the small increase in electronic heat coefficient as small additions of rhodium are made to palladium. Changes in interaction effects with composition may probably be neglected as unlikely to produce considerable differential effects over small composition-ranges. Nevertheless, it is still not to be expected that the curves will be strictly parallel since γ depends essentially on the band height while the susceptibility depends upon both band height and curvature. In view of the gentle curvature of the γ-concentration curve, however, the difference in shape of the two susceptibility–concentration curves is greater than might be anticipated.

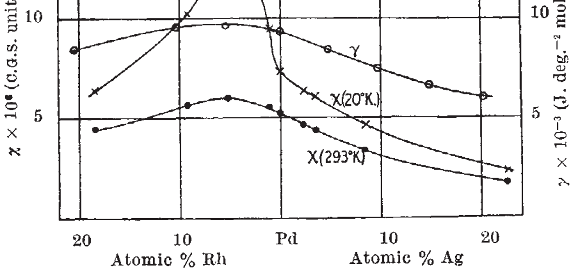

Fig. 1. Mass susceptibility, χ, and electronic heat coefficient, γ, for alloys of palladium with rhodium and silver

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[1] Hoare, F. E., Kouvelites, J. S., and Matthews, J. C., *Nature*, **170**, 537 (1952).

[2] Hoare, F. E., and Yates, B., *Proc. Roy. Soc.*, A, **240**, 42 (1957).

Attractive Forces between Flat Plates

Some years ago investigations were carried out concerning attractive forces between glass and quartz bodies with flat polished surfaces[1]. Due to the well-known hygroscopic behaviour[2] of these surfaces, however, silica-gel obstacles were always present on the plates. These obstacles had a tendency to decrease the attractions and even to turn them into repulsions. Therefore metal plates have now been used instead of glass or quartz. The technique used was similar to that described earlier[1]. The main difficulties were caused by dust particles, and general agreement was found with the conclusions obtained in recent work[3] on the influence of dust particles on the contact of solids. Obstacles (smaller than 10μ) are distributed at random on the plates and show, especially in the case of aluminium plates, some 'compressibility'.

One of the plates could be moved by means of a lever system in a vertical direction towards, or away from, the other plate. This other plate was attached to a spring system. The lever system was checked by capacity measurements and showed a reproducible hysteresis behaviour, the loop-width of the hysteresis curve being 0·20–0·22 micron. This hysteresis behaviour was due to a knife-edge contact in the lever system. Knife-edge contacts, or in general frictional contacts, must therefore be avoided, unless under critical control. Once the properties of the lever system were known accurately, the distance between the metal plates during an experiment was easily calculated, provided the distance at the beginning of an experiment was known. This distance was about 5 microns and was conveniently varied between 2 and, say, 10 microns with an accuracy better than 0·01 micron. The ultimate attractive force K was measured by means of a capacity method.

The measurements, between two chromium plates or between two chromium-steel plates, indicate that Casimir's relation[4] $K = Ad^{-4}$, where d is the distance between the plates and K is the force per unit area of the metal surface, was not contradicted. The constant A was found to be 0·01–0·04 × 10^{-16} dynes cm.^{2}, whereas its theoretical value is 0·013 × 10^{-16} dynes cm.^{2}. The uncertainty was due to errors in