

of the deformed facet was measured using an optical goniometer and was found to be $21.7 \pm 0.1^\circ$ away from the plane of the undeformed (010) facet. The lattice distortion is shown in Fig. 2, the original unit cell becomes triclinic but a new monoclinic cell can be defined as shown in the figure. The *a*-axis is unchanged but the *b*-axis is reduced from 14.93×10^{-10} to 13.7×10^{-10} m and γ is decreased from 118.14° to 119.9° . The dimensions of the polymer backbone can be determined from the resonance Raman spectrum, since only vibrations of the backbone are observed and these are sensitive to changes of bond lengths and angles [3, 6–8]. The spectra of the deformed and undeformed regions were identical, thus the *c*-axis must be unchanged in the new cell. The new cell has a 7% smaller volume than the original cell so that there must be considerable rearrangement of the side groups. Further studies are in hand in order to determine the form of the distortion for the other deformation system.

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Hardness and constitution in rhodium-cobalt alloys

This note describes some experiments which were carried out to provide background for an investigation [1] into some physical properties of rhodium-rich rhodium-cobalt alloys. In view of the fragmentary nature of the information, it would be inappropriate to be other than brief. However, the reader may like to be reminded that the rhodium-cobalt system is apparently simple, with complete solid solubility between rhodium and the high-temperature phase of cobalt. Interest arises from the allotropic change in cobalt, and its temperature variation with alloying; the transformation temperature, after rising to a maximum near 16% rhodium, decreases steadily to approximately room temperature at 50% rhodium (the highest rhodium content studied by Köster and Horn [2, 3]). It was not unreasonable to expect possible martensitic change at subzero tem-

peratures in rhodium-rich alloys, and hardness measurement was, therefore, a convenient tool for an investigation. Essentially, then, samples, which actually span a somewhat wider range of composition than has been indicated, have been subjected to low temperatures and the hardness variations used as indicators of structural change.

Alloy buttons weighing less than 1 g were prepared in an argon arc furnace from metals of approximately 4N purity. The buttons were tested using a Vickers microhardness attachment with a load of 200 g; they were then sealed in evacuated silica capsules, homogenized for 16 h at 1150°C , water-quenched and re-tested. Subsequently, the buttons were immersed for 5 min in liquid nitrogen, then in liquid helium, and hardness tested after each cooling treatment. The results are presented in Fig. 1, where each inset shows a graph, for a single composition, of the hardness (range 200 to 400 kg mm^{-2}) for each of the four heat-treatment states.

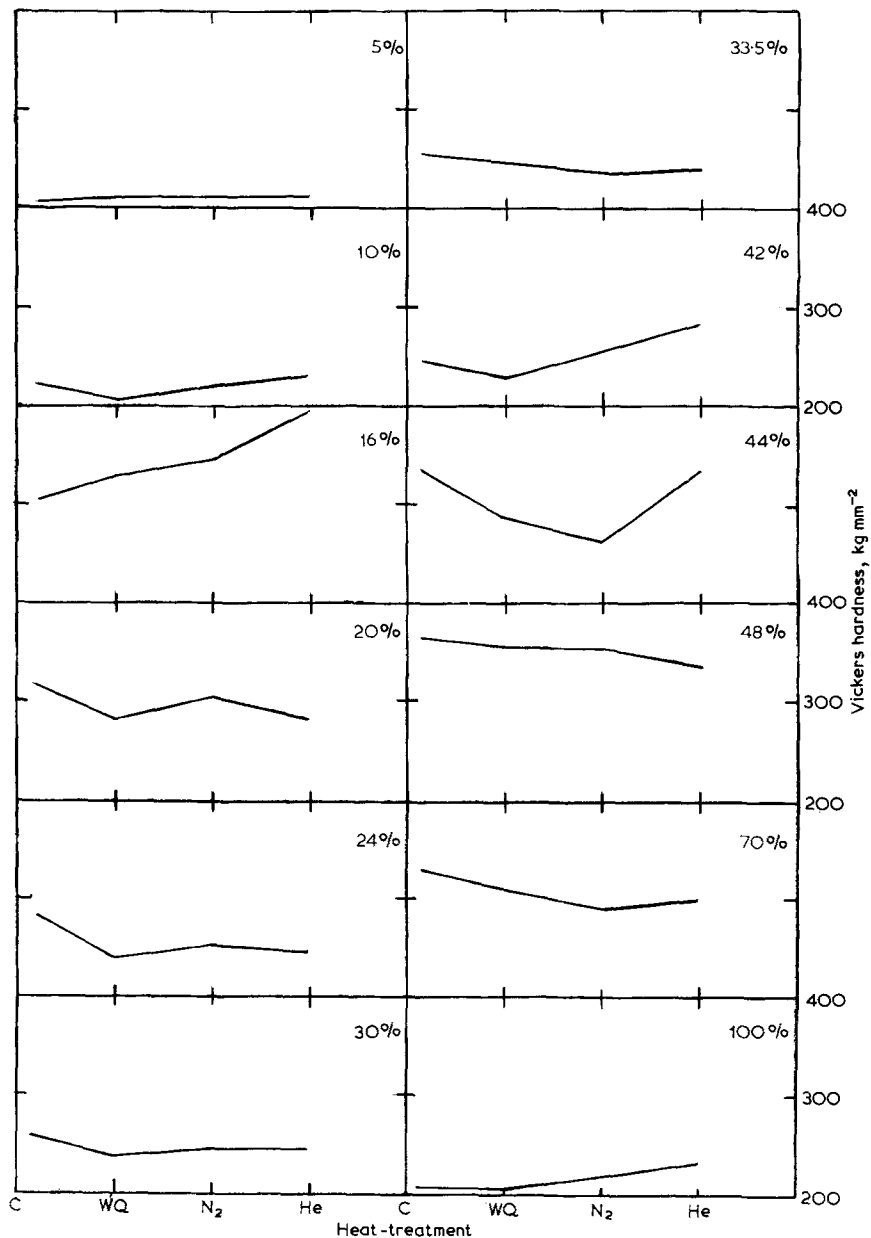


Figure 1 Variation of hardness with heat-treatment for some rhodium-cobalt alloys. The separate frames are characterized by cobalt content (5, 10 etc.). Percentages here and in the text are atomic. C = cast; WQ = homogenized and water quenched; N₂ and He = after heat-treatments at 77 and 4.2 K respectively. Hardness in kg mm⁻²; at least three impressions at each stage. For clarity, individual datum point markings have been omitted. The hardness of pure rhodium was in the range 175 to 191, depending on the treatment. Hardness/depth profiles (not illustrated) using the complete range of loads available (5 to 200 g) showed that maximum recorded hardness was typically attained with a 20 g load; hardness figures at 100 g load were of the order of 90 less than the maximum, but the further decrease to that at 200 g load was approximately 10.

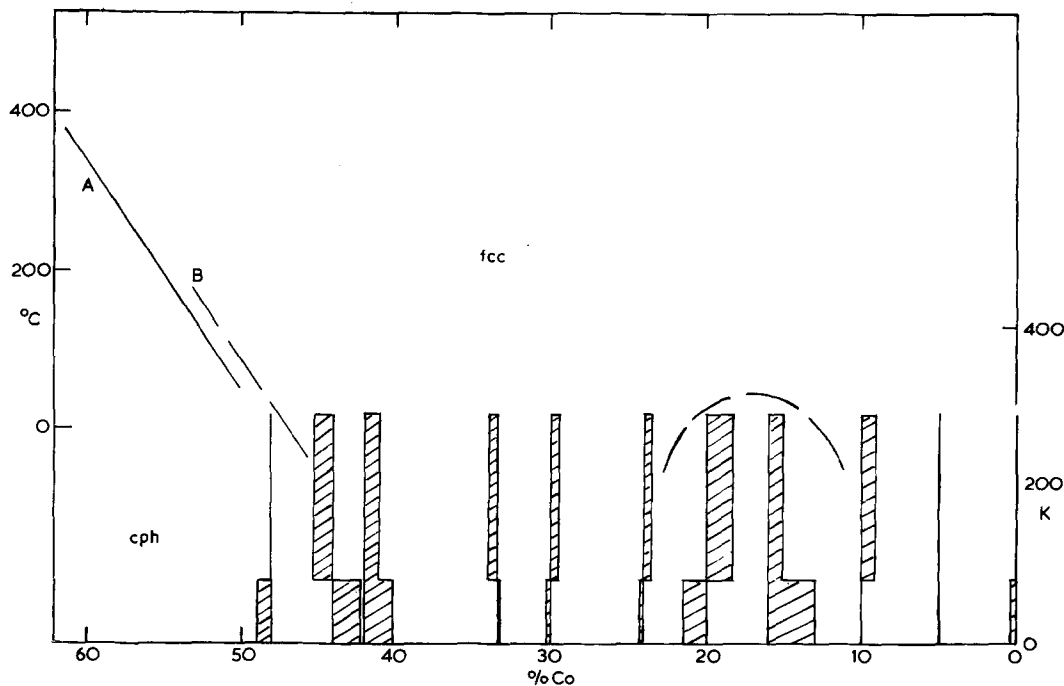


Figure 2 Low temperature rhodium-rich part of the Rh-Co phase diagram with superimposed indications of hardness changes. The changes for the heat-treatment steps $290 \rightarrow 77$ K and $290 \rightarrow 4$ K (from Fig. 1) are indicated as shaded areas of width proportional to the magnitude of the change which extend to the right to indicate hardening and to the left for softening. Line A = the $\alpha \rightarrow \epsilon'$ realization line from previous work [2, 3] and B is the suggested continuation to higher rhodium contents. The dashed line at approximately 16% Co indicates the possibility of phase changes associated with the hardness differences there.

In interpreting the information, one may consider both the level of hardness, and the hardness variation with heat-treatment. Melts with 0, 5, 10 and 100% cobalt have a comparatively low and fairly steady hardness, whilst alloys containing 30 and 33.5% have higher hardness which, however, is again nearly constant for the various treatments. Therefore, one may infer that hardness-sensitive structural changes occur in two ranges of composition, namely, from 13 to 20% inclusive, and from about 35% upwards. This is perhaps more clearly seen if the hardness differences are marked in (Fig. 2) on the phase diagram. Consideration of the hardness changes resulting from the treatments $295 \rightarrow 77$ and $77 \rightarrow 4.2$ K, respectively, for alloys containing more than 35% cobalt would suggest that the maximum probability line in the diagram for the transformation $\alpha \rightarrow \epsilon'$ runs from 360 K at 50% Co to 76 K at 40% Co. This agrees very nearly with an extrapolation of the data given by

Köster and Horn [2] as reported in Hansen [3], for alloys with 50% and more of cobalt. The evidence of structural changes at lower cobalt contents (13 to 20%) is more difficult to assess, although it may be consistent with the presence of a dome-shaped phase field with a maximum at about 320 K, widening to between 7 and 25% Co at 77 K.

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