

on knowledge of phase relationships, but it was implicitly accepted that a platinum metal was needed as a major constituent in order to resist oxidation.

The paper summarises the results of tests on the strain sensitivity, electrical resistivity, temperature coefficient of resistivity, and ultimate tensile strength of the systems of alloys of palladium with silver, ruthenium, osmium and molybdenum, and of platinum with gold, osmium and tungsten. Tests were also made on some alloys in the ternary systems palladium - rhodium - ruthenium, platinum - osmium - iridium, palladium - ruthenium - molybdenum and platinum - osmium - tungsten, as well as on some base metal systems.

From an electrical point of view, the molybdenum-palladium alloys were selected as having the most favourable properties, but their resistance to oxidation was found to be inadequate.

To improve oxidation resistance, platinum was substituted for part of the palladium; and the final conclusion was reached that of all the alloys tested the most suitable for use at high temperatures was the 45:45:10 platinum-palladium-molybdenum alloy. This has a temperature coefficient of resistance of 100 microhms per ohm per degree C, and a strain sensitivity at room temperature of 4.0. No prediction, however, is attempted of an upper safe temperature for its steady use.

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## Selective Diffusion of Hydrogen Allotropes through Palladium

The isotopes of hydrogen diffuse through palladium at different rates, and several processes which utilise this effect for the concentration of deuterium have been established on an industrial scale. Some corresponding effects involving the ortho and para allotropes of hydrogen have recently been reported by L. Fitoussi of CEN Saclay (*Compte Rend. Acad. Sci.* 1968, **266**, (C), 164) and, in view of the considerable differences in diffusion rates observed, the experimental findings deserve careful consideration.

The tests were made on a palladium membrane of unspecified thickness which was maintained at 175°C and subjected to an upstream hydrogen pressure of 30 Torr. The downstream side of the membrane was continuously evacuated. Diffusion rates measured with ordinary hydrogen (25 per cent para-hydrogen) increased initially to a peak value of 1.3 arbitrary units and subsequently decreased slowly to a steady state value of 1 arbitrary unit. Rapid evacuation of the upstream side of the membrane followed by admission of fresh hydrogen momentarily increased the diffusion rate to 1.3 units after which a gradual return to steady state conditions was observed.

These findings were interpreted as an indication that diffusion was being inhibited by the development of an adsorbed layer of

ortho hydrogen on the upstream surface of the palladium membrane. When the proportion of para hydrogen in the feed gas was gradually raised from 25 to 50 per cent the diffusion rate increased by a factor of 6.5.

If para hydrogen diffuses so much faster than ortho hydrogen it is difficult to understand why the output of laboratory and commercial diffusion units run from gas cylinders should remain constant over long periods of time. Such units are of course run at temperatures and pressures much higher than those reported in this paper. The effectiveness of the hydrogen/deuterium separation processes can of course easily be correlated with the  $\alpha$  to  $\beta$  phase changes in the palladium and it is possible therefore that in his selection of experimental conditions L. Fitoussi may have hit upon temperatures and pressures particularly favourable to selective allotropic diffusion.

It seems very significant, however, that the 50 per cent para hydrogen mixture which provided high diffusion rates was continuously circulated over the membrane surface. The ordinary unenriched hydrogen which diffused very slowly was not circulated, nor was any bleed-off provided in the vicinity of the membrane. Such stagnant conditions are well known to inhibit rapid diffusion.

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