

precisely under the conditions mentioned, there is an increase in the amount of ascorbic acid on incubation with mannose. The ascorbic acid value thus obtained after incubation with mannose in air is, however, invariably lower than the value obtained with the fresh tissue, and cannot naturally be compared with it. The figures obtained after incubation with and without mannose are alone comparable. It appears from these results that molecular oxygen is necessary for the conversion with which we are dealing.

Similar results have been obtained with the aqueous extracts of germinated *Phaseolus mungo*, which can also convert mannose into ascorbic acid at pH 5.8 in a closed volume of air but not in nitrogen. Numerous experiments have been carried out in this connexion, and they will be reported later.

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### Expansion Pressures of Metallic Hydrogen and Deuterium

FROM a recent calculation<sup>1</sup>, it follows that the striking difference in properties between hydrogen and lithium is due to the great stability of the covalent H-H link. Metallic hydrogen (the analogue of metallic lithium) would be formed from hydrogen atoms with an evolution of about 10 kcal. per gm. atom, but is only stable with respect to diatomic hydrogen molecules at pressures not less than  $2.5 \times 10^6$  atmospheres.

Although these pressures have not been experimentally realized, it is possible to investigate the properties of metallic hydrogen (Graham's hydrogenium) in some of its alloys. There is evidence that in the 'hydrides' of transitional elements such as tantalum, palladium and nickel, as well as in solutions of hydrogen in other metals at high temperatures, the hydrogen is in the metallic state, that is, is dissolved as atoms, and is partly dissociated into protons and electrons<sup>2</sup>.

One of the most readily investigated properties is the expansion pressure. Although on purely geometrical grounds the hydrogen atoms and protons could fit into the interstices of the metal lattice with which the hydrogen is alloyed, metallic hydrogen exerts a considerable expansion pressure. For palladium, with a compressibility of approximately  $0.4 \times 10^{-6}$  per atmosphere, an expansion pressure of  $2.5 \times 10^6$  atmospheres would lead to an expansion of 10 per cent in volume, whereas the observed value, when approximately 0.5 gm. atom H is added per gm. atom Pd, is 11 per cent.

In a recent communication<sup>3</sup>, a method is described for investigating special problems in the structures of solids, by making use of the differences in zero point energy when deuterium is substituted for hydrogen. The changes are usually quite large enough for X-ray investigation, and provide an additional parameter which can be varied in studying the equilibrium of the lattice. In the case of the metallic linkage, for example, it is possible to obtain an estimate of the differences in expansion pressures

of metallic hydrogen and deuterium, by measuring the expansion of the palladium lattice when alloyed with each of these isotopes.

As is discussed in a forthcoming publication, the expansion of the palladium lattice leads to an increased heat of solution of hydrogen, with the result that below about 300° C. two phases with atomic ratio H/Pd about 0.02 and 0.5 are formed, with the same lattice structure and the same dissociation pressure of hydrogen. By investigating these two phases in equilibrium, when either hydrogen or deuterium is dissolved in palladium, it is found that the average expansion in the lattice parameter on forming the  $\beta$ -phase is  $0.1430 \pm 0.0004$  A. for hydrogen,  $0.1325 \pm 0.0004$  A. for deuterium. The concentration of deuterium in the  $\beta$ -phase is slightly greater than in the case of hydrogen, and the expansion pressures of these two isotopic metals differ by about 7 per cent.

The lattice energy of transitional metals appears to be particularly sensitive to volume changes, and information about the energy changes involved may be obtained by alloying with each of the two isotopes.

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- <sup>1</sup> Wigner and Huntington, *J. Chem. Phys.*, **3**, 764 (1935).  
<sup>2</sup> cf. Ubbelohde, *Trans. Far. Soc.*, **28**, 275 (1932).  
<sup>3</sup> Ubbelohde, *Trans. Far. Soc.*, **32**, 525 (1936).

### Viscosity of Binary Mixtures

SEVERAL attempts have been made to represent the viscosity,  $\eta$ , of a mixture, as a function of the concentrations,  $c_1$  and  $c_2$ , and the viscosities,  $\eta_1$  and  $\eta_2$ , of the components. So far as we are aware, all investigators (with the exception of Dolezalek) have used the general form:

$$f(\eta) = c_1 f(\eta_1) + c_2 f(\eta_2)$$

with various expressions for  $f$ , such as  $f = \log \eta$  (Arrhenius),  $f = 1/\eta$  (Bingham),  $f = \eta^{1/3}$  (Kendall and Monroe). The latter demonstrated very clearly that, with any of these functions, deviations up to 20 per cent and more appear, when used for mixtures of two liquids with very different physical constants. As a matter of fact, there is no reason to suppose that any expression of this general form can give satisfaction.

Let  $N_1$  and  $N_2$  be the mole fractions of the two components; let us denote by  $z_1$  the interaction of one particular molecule of kind 1 in the layer  $A$  with a molecule of the same kind in layer  $B$ , and by  $z_{12}$  the interaction with a molecule of kind 2. The relative amounts of these interactions of the molecule in the layer  $A$  will be proportional to their probabilities, and thus, in the simplest case, also proportional to the number of the molecules of kind 1, respectively kind 2 in the layer  $B$ , that is, to  $N_1$  and  $N_2$ . The relative amount of the interaction between the two layers  $A$  and  $B$  generated by the total number of molecules of kind 1 is then again proportional to  $N_1$ , and thus amounts to  $(N_1 z_1 + N_2 z_{12}) \cdot N_1$ . Similarly, that of the molecules of kind 2 amounts to  $(N_2 z_2 + N_1 z_{12}) \cdot N_2$ . If  $z$  denotes the total interaction, we may thus write:

$$z = N_1^2 z_1 + 2 N_1 N_2 z_{12} + N_2^2 z_2;$$

and as we may put  $N_1 + N_2 = 1$ ,

$$z = N_1^2 (z_1 + z_2 - 2z_{12}) + 2N_1 (z_{12} - z_2) + z_2 \quad (1)$$