

Studies of the Absorption of Hydrogen on a Palladium Carbon Catalyst

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The platinum-carbon-hydrogen-system has been investigated by several groups¹⁻³⁾ in recent years. The absorption of hydrogen on a palladium carbon catalyst (Pd-C) has been studied and some interesting information gained. It is known that hydrogen is only physically adsorbed on carbon at room temperature. Above 600°C hydrogen is chemisorbed on carbon.⁴⁾

In this study, extraordinary absorption of hydrogen on Pd-C has been found. That is, the net amount absorbed on carbon (the amount absorbed on Pd-C minus that absorbed on palladium alone) is several hundred times that adsorbed physically at the same temperature. The measurements were made in a constant-volume apparatus. Carbon had been soaked in a 10% hydrofluoric acid solution in order to eliminate impurities. The required amount of palladium chloride solution was dispersed impartially over carbon to make a Pd-C catalyst. The catalyst, after it had been fully washed by ion-exchanged and distilled water, was put into the cell in a wet state and evacuated at 250°C.

The hydrogen for absorption measurements was made by the electrolysis of a 20% sodium hydroxide solution and purified by passing it through a palladium asbestos tube heated to 200°C.

A typical run of experiments is shown in Fig. 1. From this figure, it is evident that the amount absorbed on Pd-C is much larger than that which would be adsorbed physically. The correlation between the over-all amount of hydrogen absorbed and the pressure at equilibrium is shown in Fig. 1 also.

Apparently the amount absorbed is proportional to the square root of the pressure at equilibrium over the range from 0 mmHg to 80. This pressure dependence indicates a dissociative absorption of hydrogen. The effect of the amount of palladium on the absorption rate is illustrated in Fig. 2. This figure suggests that the initial rate of absorption is

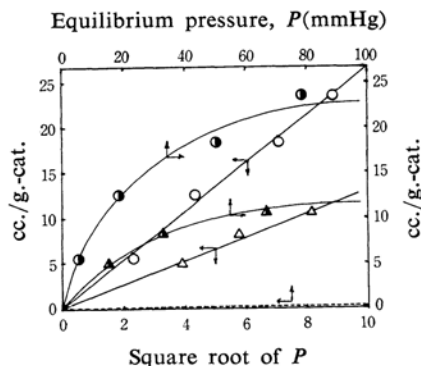


Fig. 1. Dependence of the amount absorbed on 5%Pd-C on equilibrium pressure. Experimental results: ● at 150°C, ▲ at 200°C, the amount physically absorbed on Pd only (the amount on C only is negligible). Avanged values with \sqrt{P} : ○ at 150°C, △ at 200°C.

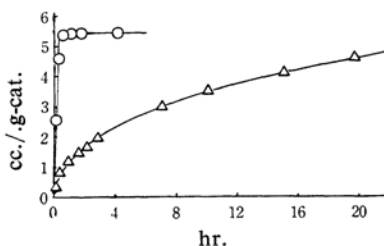


Fig. 2. Effect of the amount of Pd on the absorption rate at 150°C. ○ 5%Pd-C, △ 1%Pd-C

roughly proportional to the amount of palladium in the catalyst under the same initial pressure of hydrogen, and that the amounts absorbed at equilibrium are the same, irrespective of the palladium content.

The above information leads to several conclusions. The palladium in the catalyst plays the role of dissociating the hydrogen, which then migrates to the carbon surface and is stored there. The kinetic data predict that the rate-determining step of this absorption process is the diffusion of hydrogen from palladium to the carbon surface.

Gases other than hydrogen were found in the desorbed gas at 250°C.

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