"Uphill" hydrogen diffusion effects and hydrogen diffusion coefficients in palladium

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Abstract

Information concerning measurements of hydrogen diffusion coefficients over α- and β-phase ranges of hydrogen content in the palladium/hydrogen system is summarized. The utilization of palladium as a hydrogen purification membrane has constituted a background for observations of "uphill" hydrogen diffusion effects. Observations of "uphill" features have been recorded for membranes in forms of both tubes and sheets. Experimental procedures have been developed to introduce hydrogen into outer (external) surfaces and to monitor hydrogen permeation through the walls by changes of either pressures of hydrogen gas within the tubular membranes or of electrode potentials at inner (opposite) surfaces. For clear observations of the "uphill" effects, both surfaces of the membranes have been coated with palladium black. Following discharges of hydrogen at the outer surfaces of membranes initially containing hydrogen, the changes of hydrogen pressure within the tubes or equivalent pressures calculated from electrode potentials, showed initial periods of decreases of the hydrogen contents at opposite surfaces. This permeation behaviour has been held accountable to expansions by hydrogen of interstitial palladium sites, that have initiated strain gradients extending from outer to inner surfaces, which then induced Gorsky effect operations. A discussion is presented concerning influences of these strain gradient considerations on forms of dependence of values of hydrogen diffusion coefficients Da, on overall hydrogen contents in palladium membranes.