

# Observations of “Uphill” Diffusion of Hydrogen in Palladium and Nickel Membranes by an Electrochemical Permeation Method\*

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## *Uphill H diffusion / Pd and Ni membranes / Electrochemical permeation method*

The “uphill” diffusion of hydrogen during permeation through flat sheets of palladium and nickel has been studied by an electrochemical permeation method at 303 K. For both annealed and as cold rolled Pd samples, uphill diffusion effects during both hydrogen absorption and desorption have been observed with initial hydrogen contents ranging from about H/Pd = 0.01 up to H/Pd = 0.25–0.3. The non-Fickian permeation fluxes have been associated with lattice volume differences across the  $(\alpha + \beta)/\beta$  and  $(\alpha + \beta)/\alpha$  interfaces. Influences of magnitudes of galvanostatic currents and membrane thickness were examined. In similar studies with nickel membranes analogous uphill effects were observed.

## 1. Introduction

In studies of hydrogen permeation through tubular membranes of Pd<sub>81</sub>Pt<sub>19</sub> [1–3], Pd<sub>77</sub>Ag<sub>23</sub> [2, 4, 5] alloys and pure Pd [6, 7] already containing hydrogen, Lewis and co-workers [1–7] have reported an evidence of hydrogen migration in the opposite direction against overall imposed hydrogen concentration gradients from changes of hydrogen pressure and electrode potential on the recommencement of hydrogen absorption or desorption at outer surfaces. These findings have been attributed to Gorsky effect processes induced by lattice-expanding effects of the permeating hydrogen. The hydrogen flux,  $J_H$  can be expressed [3] by:

$$J_H = -D_H \left[ \left( 1 + \frac{\partial \ln f_H}{\partial \ln C_H} \right) \frac{\partial C_H}{\partial x} - \frac{\bar{V}_H C_H}{RT} \frac{\partial \sigma}{\partial x} \right],$$

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