# STRESS GENERATION DURING HYDROGEN TRANSPORT THROUGH Pd FOIL ELECTRODE USING BEAM DEFLECTION METHOD COMBINED WITH POTENTIOSTATIC CURRENT TRANSIENT TECHNIQUE AND CYCLIC VOLTAMMETRY

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Stresses developed have been analysed as functions of hydrogen discharging potential and potential scan rate during hydrogen transport through Pd foil electrode under the potentiostatic and potential sweep conditions, respectively, by using beam deflection method [1] combined with potentiostatic current transient technique and cyclic voltammetry.

From the analyses of anodic current transient and cyclic voltammogram measured from the electrode, it is recognised that when the potential jump/potential scan rate is small enough to be below the transition potential/transition scan rate, the hydrogen concentration at the electrode/electrolyte interface is not determined by the applied potential, but the change in hydrogen concentration at the electrode/electrolyte interface with time is then specified by the Butler-Volmer equation [2].

Fig. 1 shows the deflection transients simultaneously measured with the anodic current transients on the Pd foil electrode in 0.1 M NaOH solution by jumping the hydrogen pre-charging potential of –0.02 V(RHE) to various discharging potentials in the range of 0.2 to 0.9 V(RHE). All the tensile deflections increase to a maximum value with time and then vanish. Fig. 2 presents the deflections against the applied potential simultaneously obtained with the cyclic voltammograms at various scan rates ranging from 1 to 25 mV $s^{-1}$. During the consecutive cathodic and anodic scans in the high scan rate range 12 to 25 mV $s^{-1}$, the compressive deflection increases to a maximum value and then is completely relaxed. In the low scan rate range 1 to 12 mV $s^{-1}$, however, the deflection exhibits a maximum compressive deflection, a transition of compressive to tensile deflection, a maximum tensile deflection and finally a complete decay of the tensile deflection in sequence.

From the hydrogen concentration profile transients simulated under the two constraints at the electrode/electrolyte interface during hydrogen transport depending on the discharging potential or scan rate, we calculated numerically the deflections caused by the difference between molar volume of $\alpha$-$PdH_\delta$ near the electrode/electrolyte interface and that near the impermeable interface. From the coincidence of the deflection experimentally measured with that theoretically calculated, it is concluded that the movements of the deflection in tensile and compressive directions can be accounted for in terms of negative and positive gradients of the molar volume of $\alpha$-$PdH_\delta$ across the entire electrode, respectively.

References
[1] J.-N. Han, S.-I. Pyun, D.-J. Kim, Electrochim. Acta 44 (1999) 1797.
[2] A.J. Bard, L.R. Faulkner, Electrochemical Methods, Wiley, New York, 1980, p. 103.

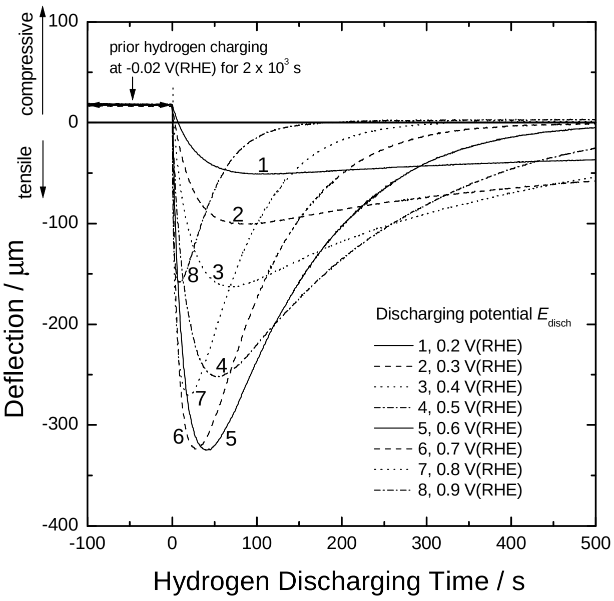

Fig. 1. Deflection transients simultaneously obtained with the anodic current transients from the Pd foil electrode in 0.1 M NaOH solution by jumping the hydrogen pre-charging potential –0.02 V(RHE) to various discharging potentials 0.2 to 0.9 V(RHE).

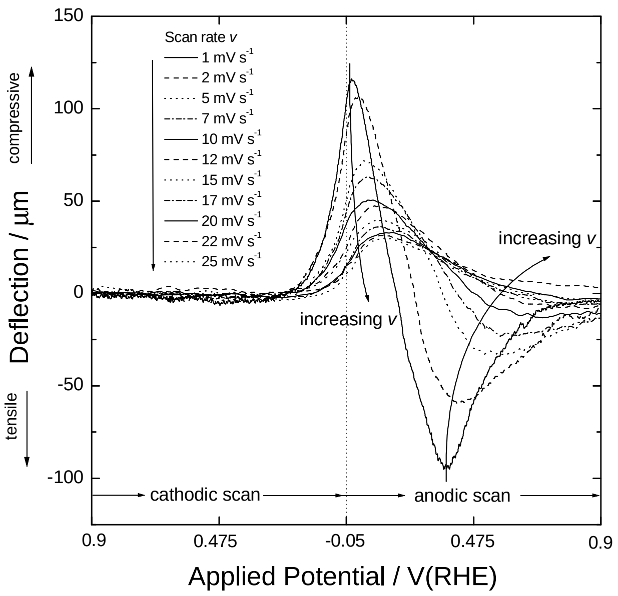

Fig. 2. Plots of the deflection against the applied potential simultaneously measured with the cyclic voltammograms on the Pd foil electrode in 0.1 M NaOH solution at various scan rates 1 to 25 mV $s^{-1}$.

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