Consumption of Pt Anode in Phosphoric Acid Solution

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Consumption of Pt anode in phosphoric acid solution has been investigated under various temperature. Consumption of the anode was evaluated as the rate of consumption, i.e., V_{corr} and the unit consumption, i.e., U_{corr}. The former represents the corrosion of Pt anode under unit time and the dimension is micro g h^{-1} cm^{-2}. While the latter is represented as micro g $A^{-1}h^{-1}$, which is independent of current density of the electrolysis.

The Pt anode was hung by a titanium electrode holder and dipped in the various phosphoric acid solutions, of which concentration was 20 – 85wt% (3 - 15M) and the temperature was varied from 20 – 80 ^{o}C. The Pt electrode was weighed before electrolysis. After the electrolysis, the electrode was washed with the hot concentrated HCl solution and was weighed. The consumption or corrosion was evaluated as the weight different. The highly oxidized Pt being soluble in the concentrated HCl solution is considered as the degraded species. The anode potential was monitored by the current interruption method which eliminated the ohmic potential drop caused by the resistance of the solution.

In the diluted phosphoric acid solution, U_{corr} was around 10 micro g A^{-1} h^{-1} which is the same order of the consumption as observed in the 1 –6 M sulfuric acid solution, while, in the concentrated solution, the huge amount of Pt (750 micro g $A^{-1}h^{-1}$) was consumed.

Dependence of temperature on the consumption was investigated. In the low concentration phosphoric acid, V_{corr} increased with increase of the temperature. On the other hand, in the concentrated solution, V_{corr} decreased with increase of the temperature. The relation between the V_{corr} and the inverse of the temperature was shown in Fig. 1. In the low concentrated solution, i.e., 20wt%, the V_{corr} increased with increase of the temperature according to a linear relation. As the concentration increases, the relation became complicated. With 70wt% solution, the same relation such as in the low concentration, was observed at the temperature range higher than 40^{o}C, however, the reverse relation was shown at lower temperature. With the concentrated phosphoric acid solution, the relation was completely inverse and the V_{corr} increased with decrease of the temperature at all temperature range.

The potential of the Pt anode was monitored with the current interruption method. The relation between the potential and the current density was shown in Fig. 2. With the solution of any concentration, the relation showed two linear relations. At the region of the higher slope, the potential increased rapidly and the potential went beyond 2.5V vs. RHE. The abnormal consumption and abnormal relation in Fig. 1 occurred at the potential region over 2.5V

Fig. 3 shows the relation between V_{corr} and the potential. This figure includes all the data taken at different concentration and also different temperature. Generally V_{corr} increases with increase of the over potential.

The surface of the Pt electrode was examined with SEM. The surface was very plain when the extraordinary consumption took place. On the other hand, when the consumption was low, the surface of the Pt was covered with oxide film and these oxide films would protect consumption.

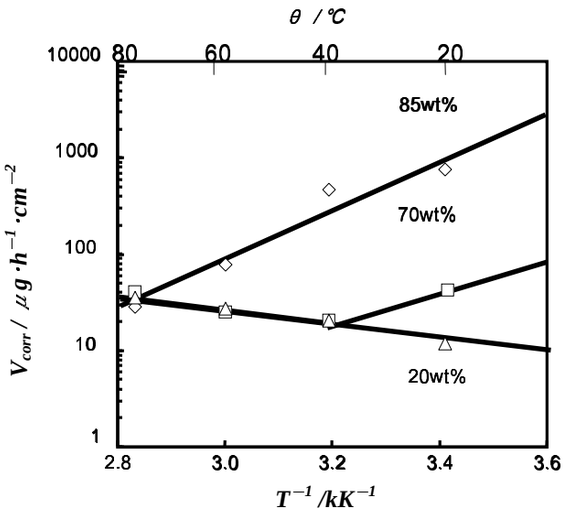

Fig. 1 Temperature dependence of V_{corr} in phosphoric acid

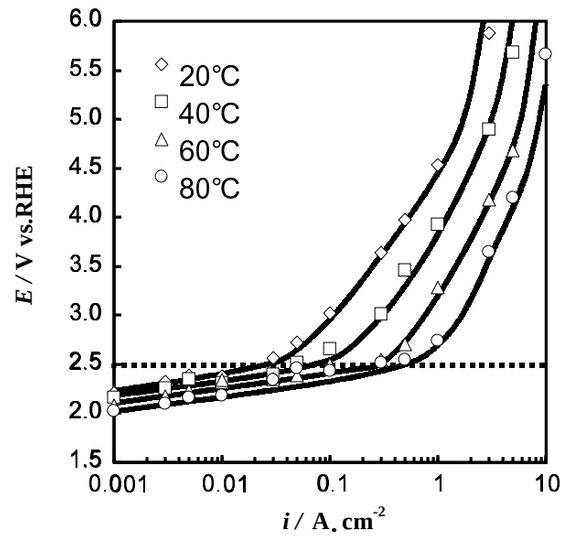

Fig. 2 i - E curve in 85wt% H_3PO_4 at 20 ~ 80℃

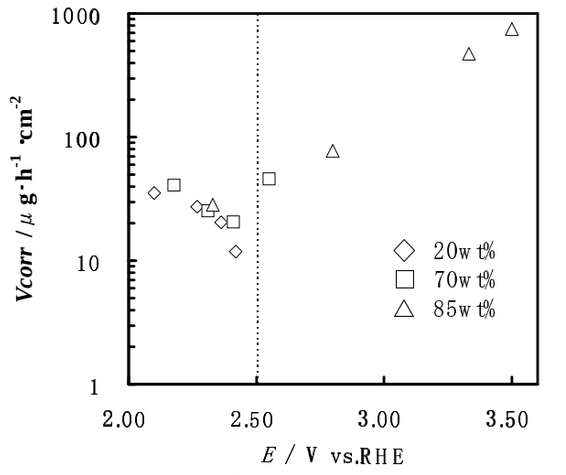

Fig. 3 Relation of Vcorr and anode potential