



## Differentiating polarization curve technique for determining the exchange current density of hydrogen electrode reaction

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(Figures)

Fig.1(a) Example polarization curves of  $E(i)$ ,  $E_a(i_a)$  and  $E_c(i_c)$  in the (A)-1

approximation. The anodic branch curve of  $E_a(i_a)$  (red dashed line) and the cathodic branch curve of  $E_c(i_c)$  (blue dashed line) are shown as a reference.

Fig.1(b) Polarization resistance curve,  $h(i)$  in the (A)-1 approximation, which is

differentiated from the  $E(i)$  curve of Fig. 1(a). The  $h(i)$  is composed of two polarization curves of the anodic branch curve,  $h_a(i_a)$  (red dashed line) and the cathodic branch curve:  $h_c(i_c)$  (blue dashed line). The curve of  $d\eta/di = h(i) = 0.013/(-i)$ , which is another expression of the Tafel relation, is shown as a reference.

Fig.2 Influence of  $l/\kappa$  on the shape of the  $h(i)$  curve. There are five example curves of

$$h(i) = 0.013 \left( \frac{1}{1-i} + \frac{1}{i+100} \right), \quad h_1(i) = 0.013 \left( \frac{1}{1-i} + \frac{1}{i+100} \right) + 0.001, \quad h_2(i) = 0.013 \left( \frac{1}{1-i} + \frac{1}{i+100} \right) + 0.01, \quad h_3(i) = 0.013 \left( \frac{1}{1-i} + \frac{1}{i+100} \right) + 0.1, \quad h_4(i) = 0.013 \left( \frac{1}{1-i} + \frac{1}{i+100} \right) + 1.$$

The line of  $h(i) = 0.013/(-i)$ , on which the Tafel relation is satisfied, is added as a reference.

Fig.3(a) Experimental polarization curves of bright Pt electrode in a stagnant 0.005 mol dm<sup>-3</sup> H<sub>2</sub>SO<sub>4</sub> solution saturated with H<sub>2</sub> gas bubbling at about 298 K (room temperature ).

Fig.3(b) Experimental polarization curves of bright Pt electrode in a stagnant  $0.05 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$  solution saturated with  $\text{H}_2$  gas bubbling at about 298 K.

Fig.3(c) Experimental polarization curves of bright Pt electrode in a stagnant  $0.5 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$  solution saturated with  $\text{H}_2$  gas bubbling at about 298 K.

Fig.4(a) Polarization resistance curve obtained by differentiating the experimental polarization curve of Fig.3(a)

Fig.4(b) Polarization resistance curve obtained by differentiating the experimental polarization curve of Fig.3(b)

Fig.4(c) Polarization resistance curve obtained by differentiating the experimental polarization curve of Fig.3(c)

Fig.5 Relationship between anodic current density of the vertical line and pH of  $\text{H}_2\text{SO}_4$  solutions.

Fig.6 Relationship between experimental polarization curve in a  $0.5 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$  solution and theoretical polarization curve. The theoretical curve is obtained by solving the differential equation under an initial experiment of  $(0, E(0))$ .

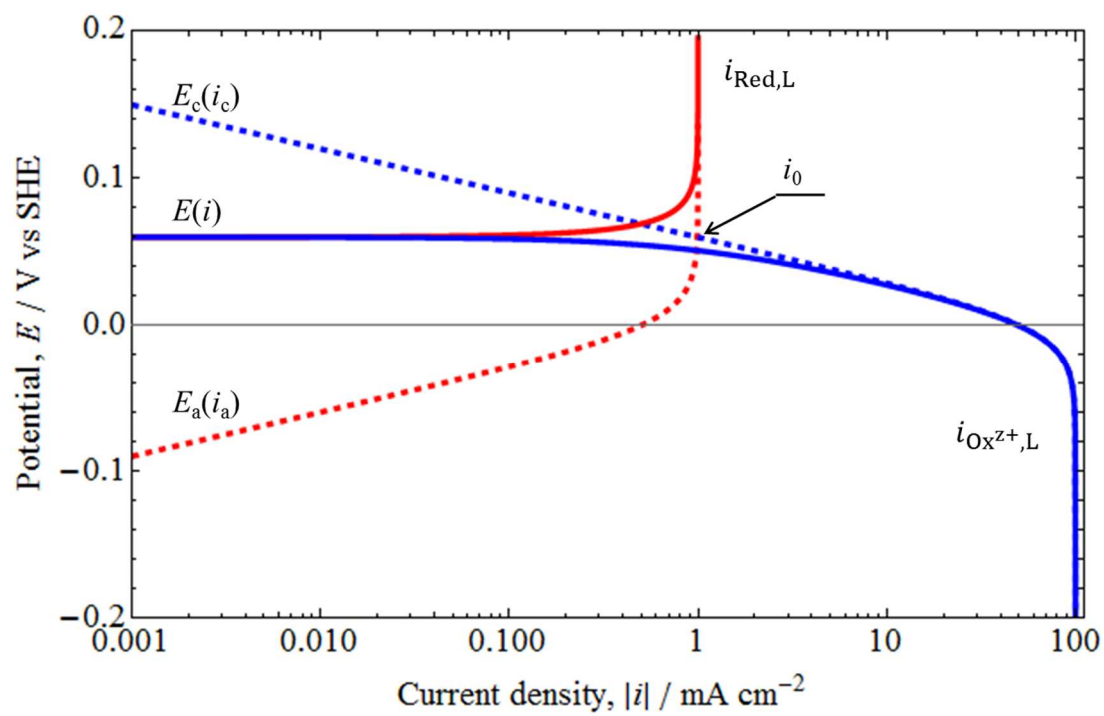


Fig. 1(a) (O.Seri and Y.Itoh)

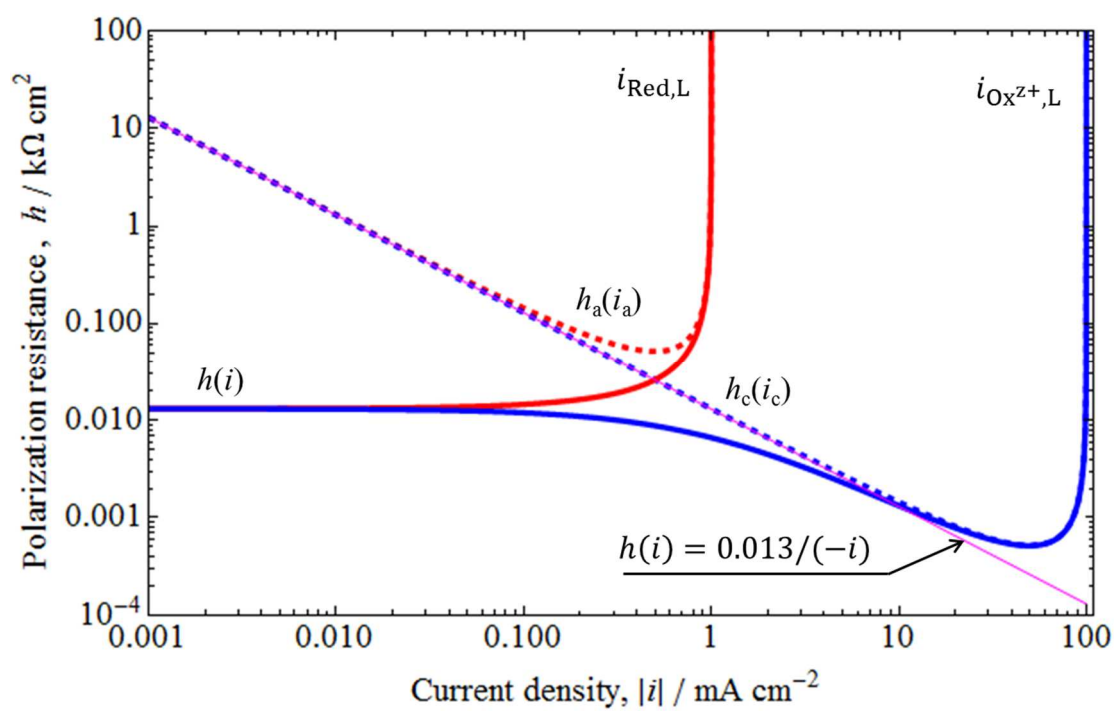


Fig. 1(b) (O.Seri and Y.Itoh)

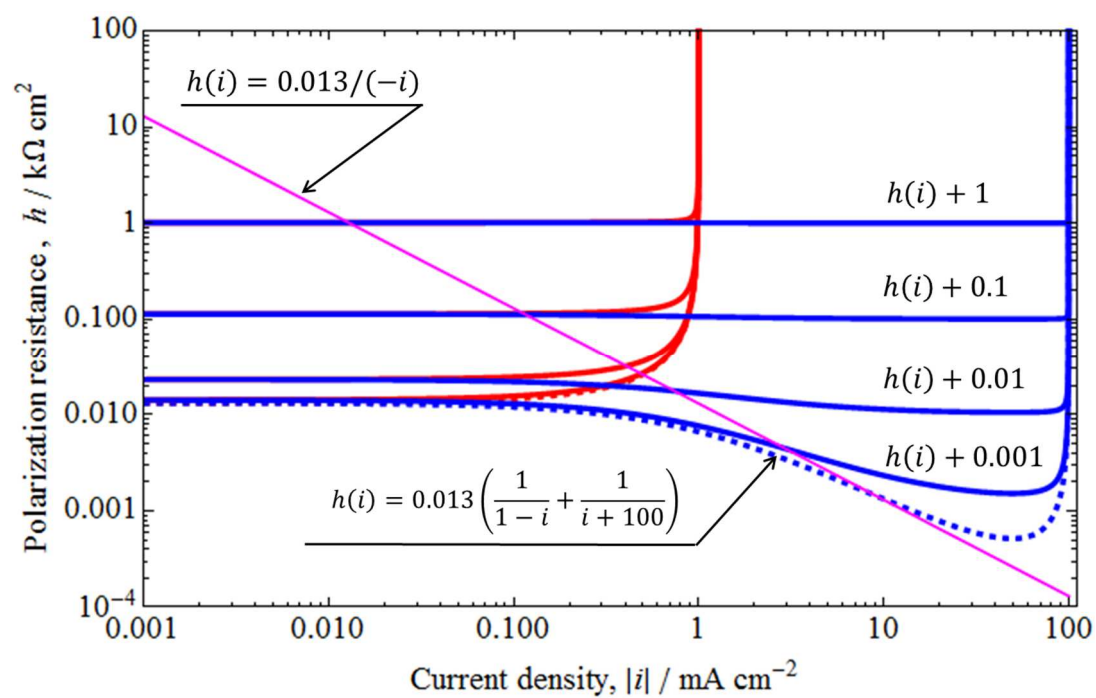


Fig.2 (O.Seri and Y.Itoh)

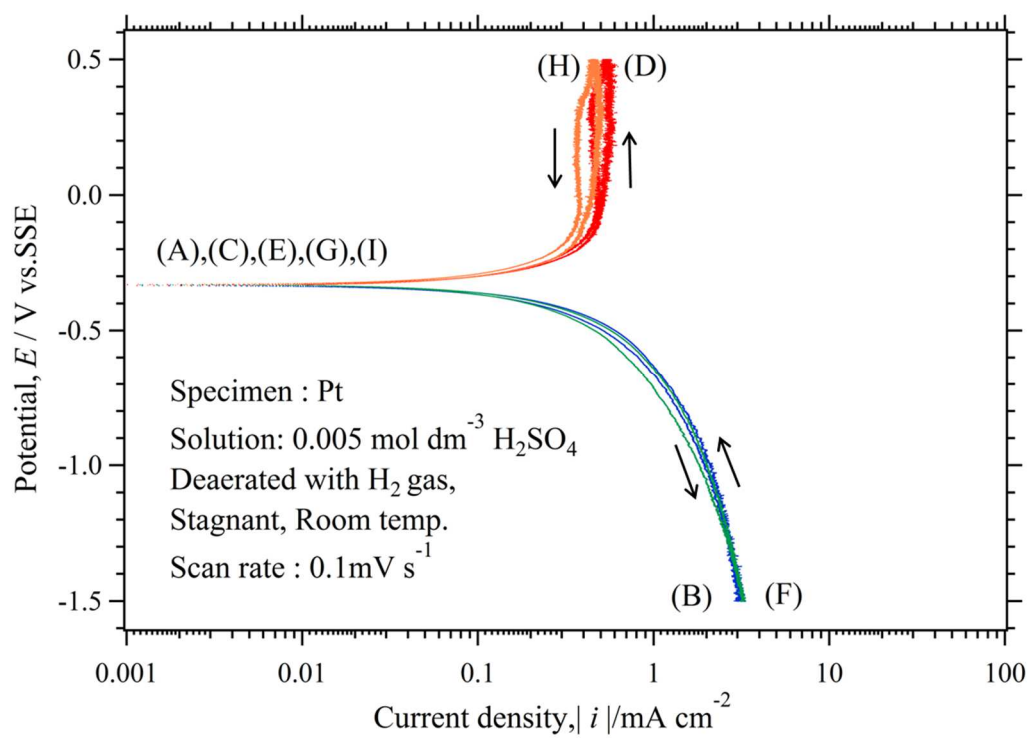


Fig.3(a) (O.Seri and Y.Itoh)

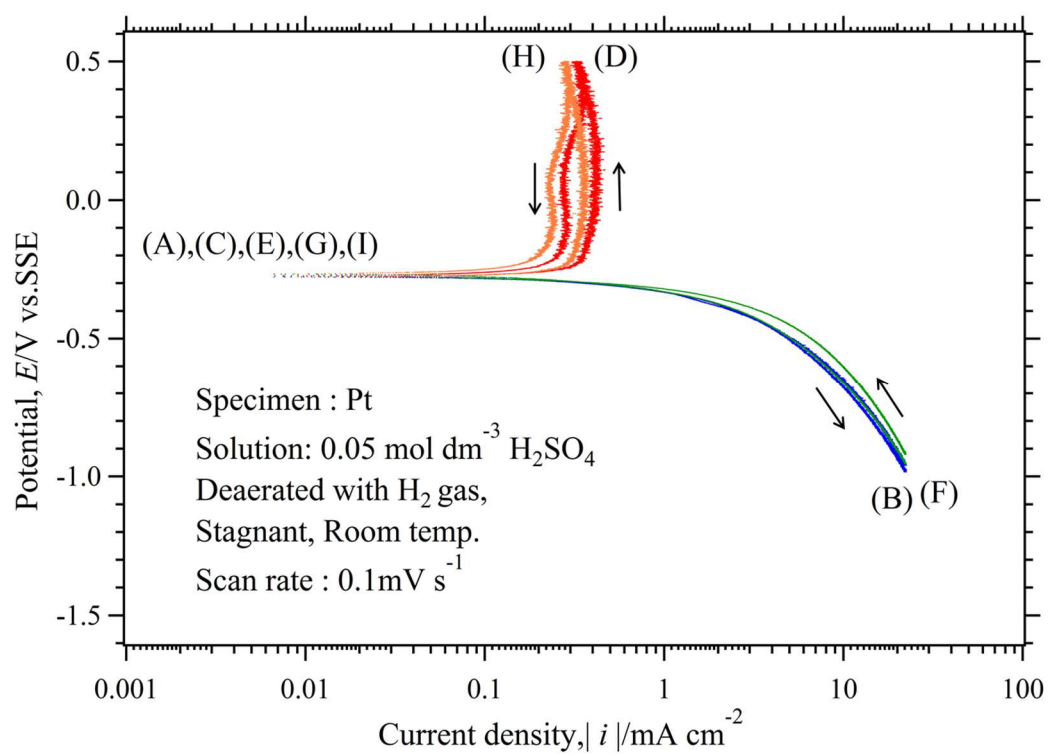


Fig.3 (b) (O.Seri and Y.Itoh)



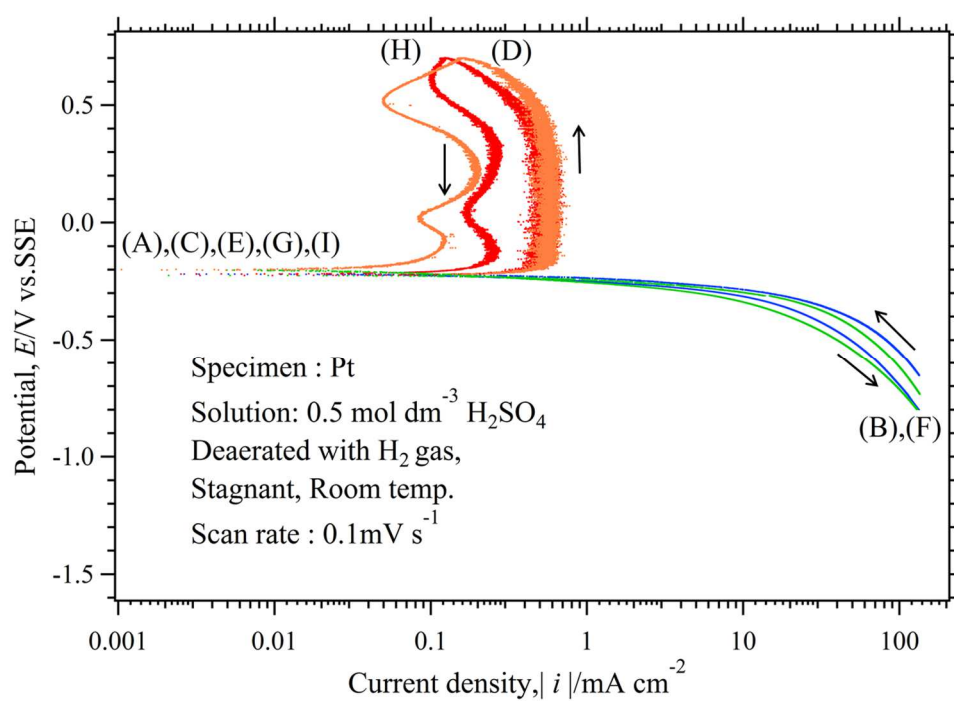


Fig.3(c) (O.Seri and Y.Itoh)

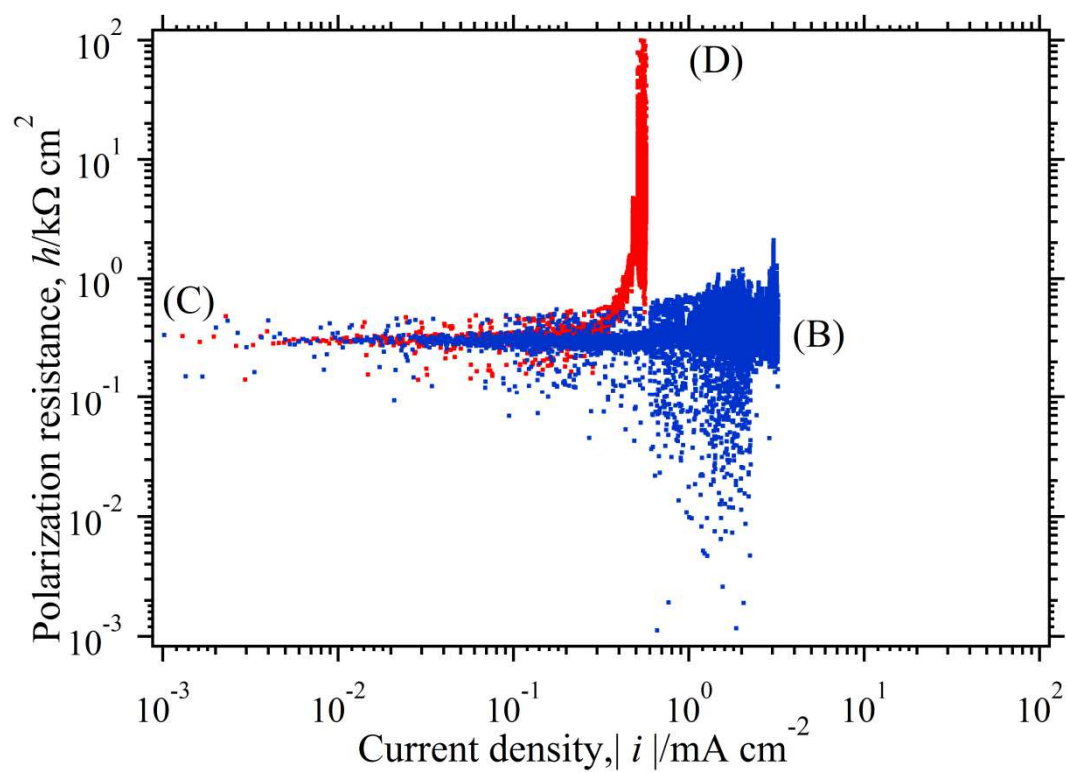


Fig.4(a) (O.Seri and Y.Itoh)

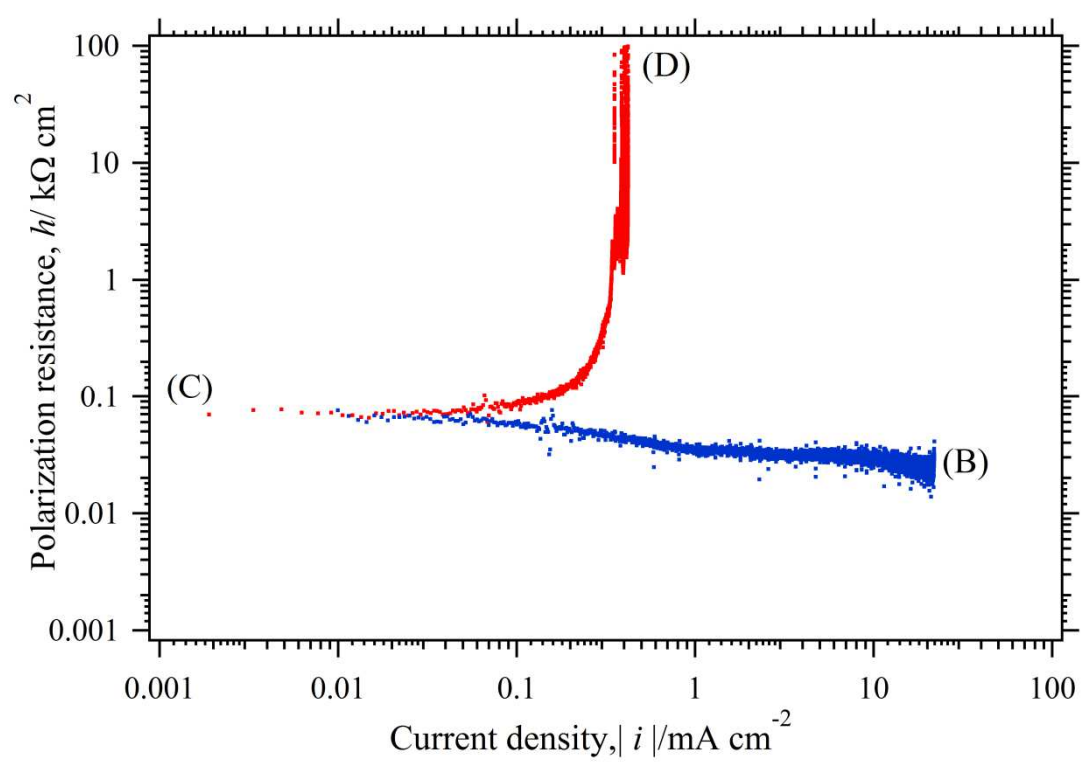


Fig.4(b) (O.Seri and Y.Itoh)

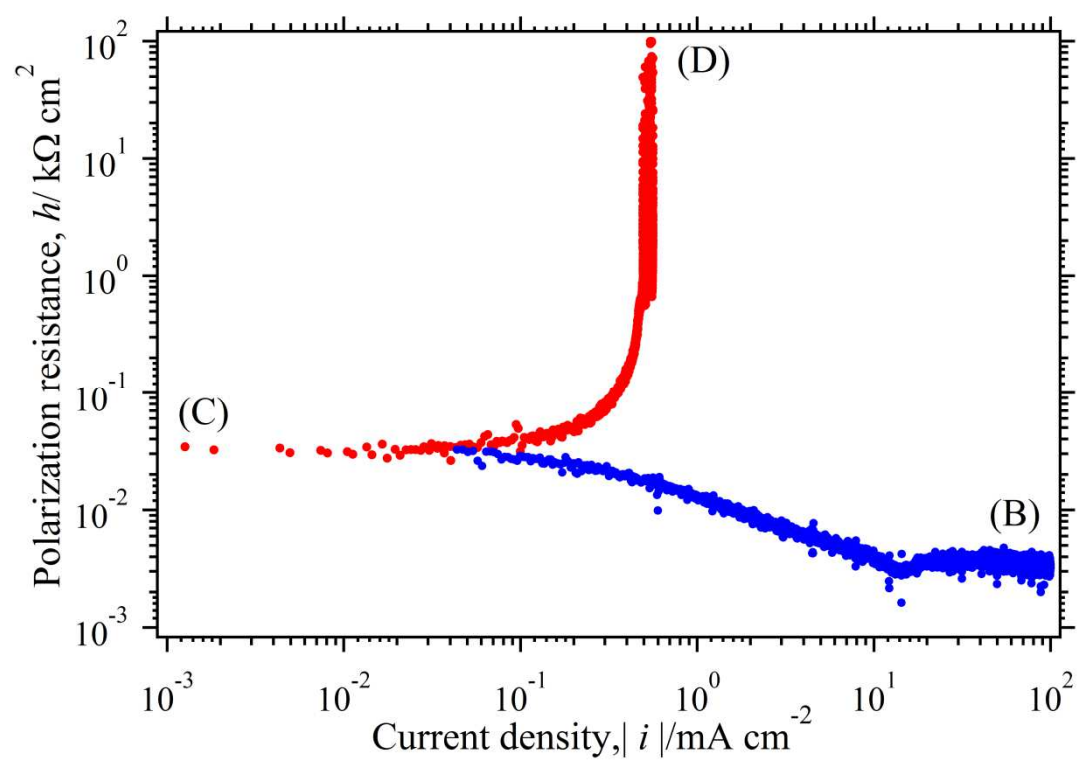


Fig.4(c) (O.Seri and Y.Itoh)

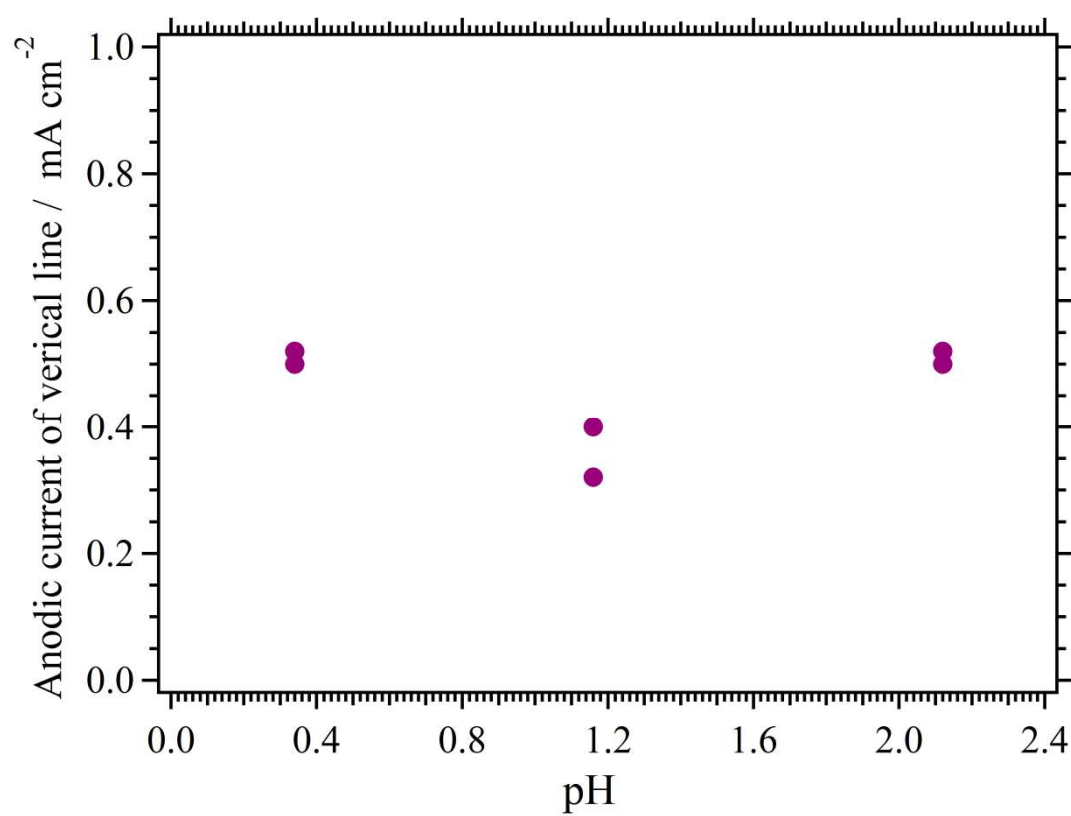


Fig.5 (O.Seri and Y.Itoh).

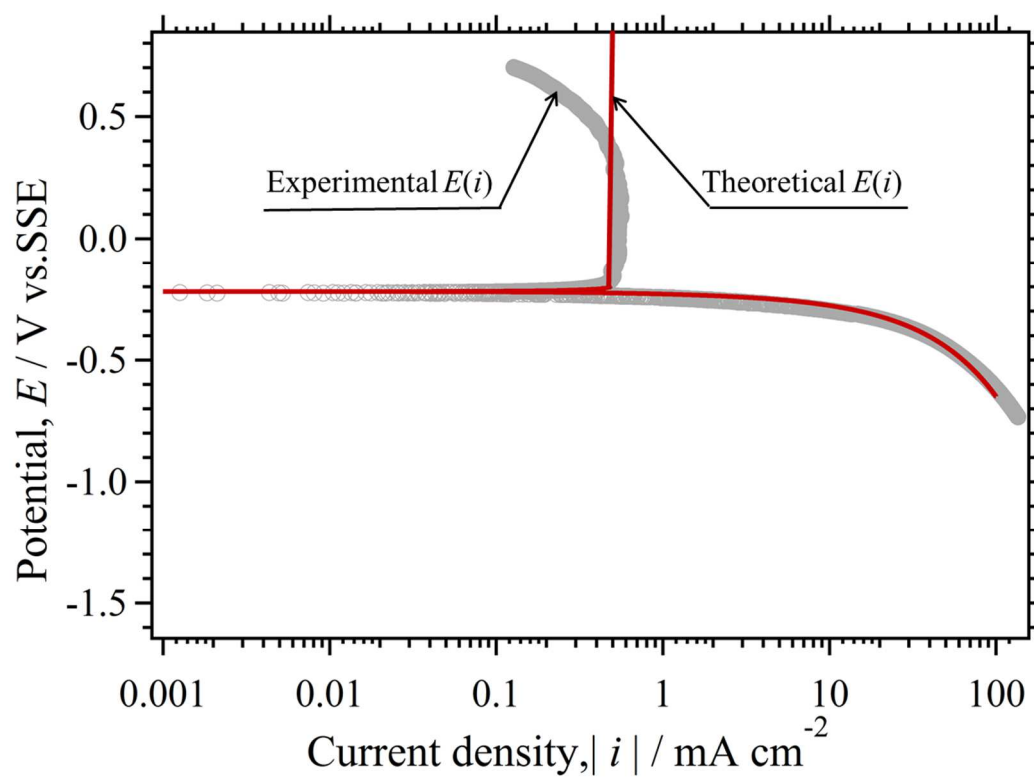


Fig.6 (O.Seri and Y.Itoh)