Electrochemical behavior of aluminum in triethylamine hydrochloride – aluminum chloride ionic liquid

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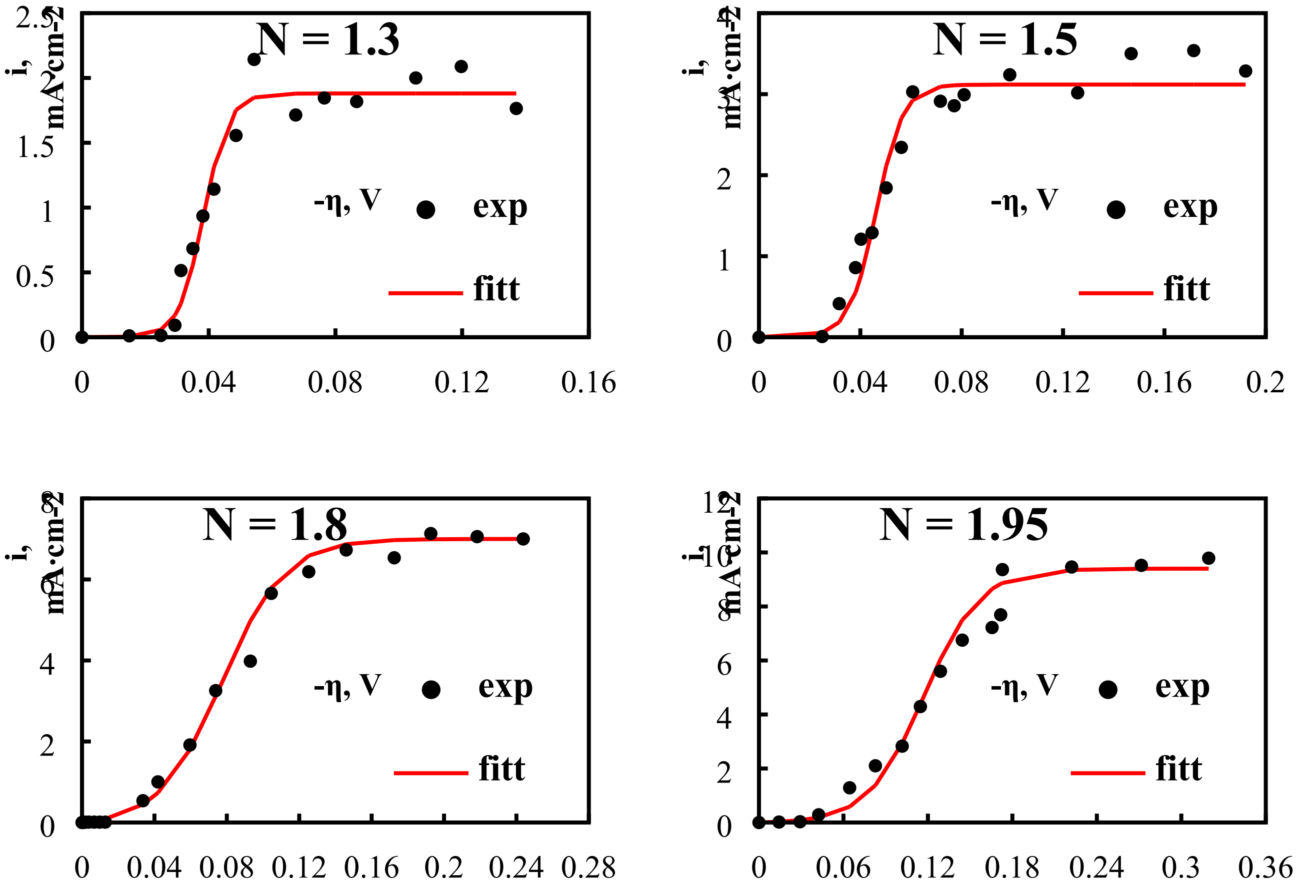
Supplementary materials



Figures s1-s4 – Experimental current density vs. cathodic overpotential at the aluminum electrode-electrolyte interface with $1.3 \leq N \leq 1.95$

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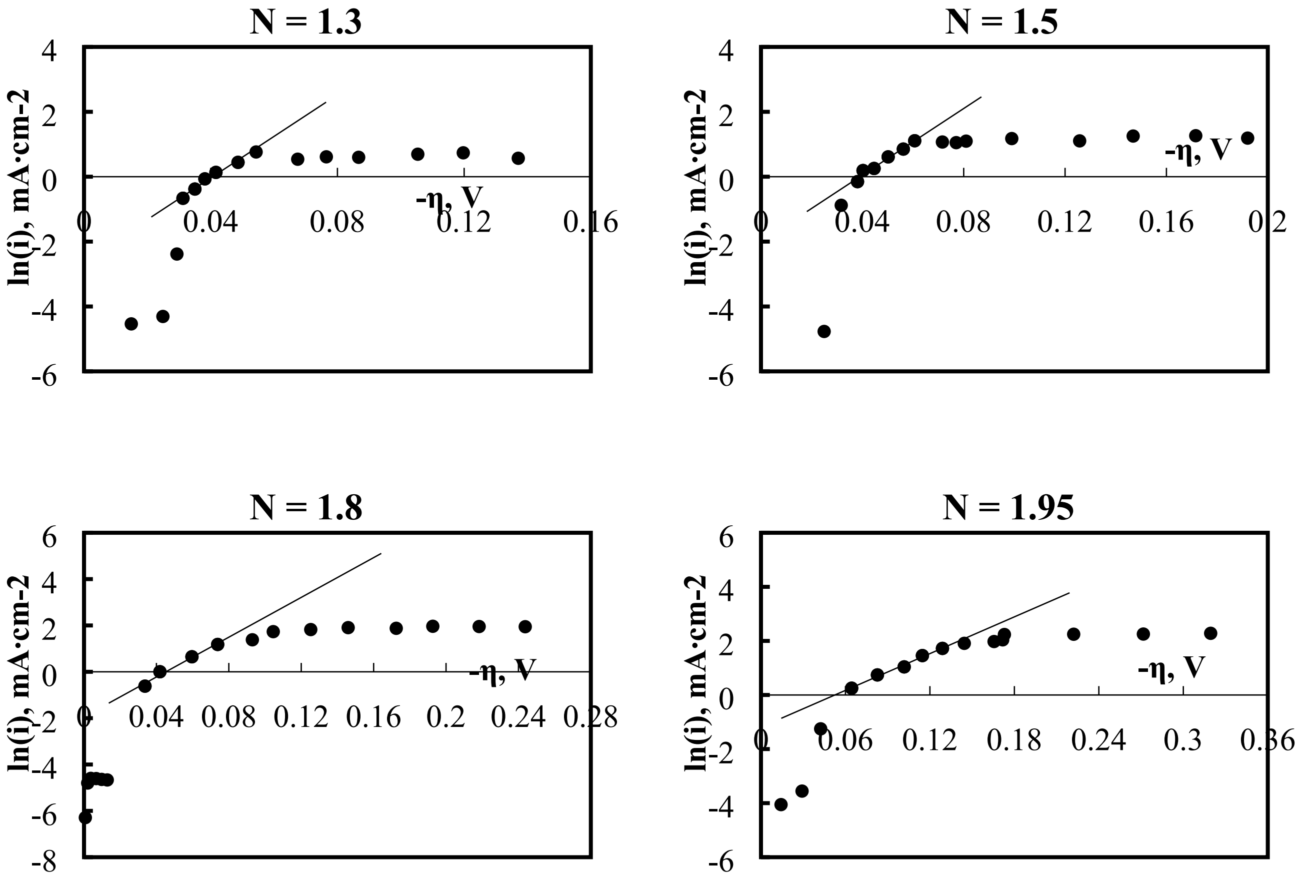

Figure s5-s8 – Cathodic polarization curves on a logarithmic current density scale

Indirect measurement error estimation

The absolute measurement error for the apparent exchange current density was calculated as the error of indirect measurements according to the equation:

$$\Delta i_0(\theta,d,T) = \sqrt{\left(\frac{\partial i_0}{\partial \theta}\Delta\theta\right)^2 + \left(\frac{\partial i_0}{\partial d}\Delta d\right)^2 + \left(\frac{\partial i_0}{\partial T}\Delta T\right)^2}, \qquad \text{(s1)}$$

where $\Delta\theta$, Δd and ΔT are the absolute errors for the charge transfer resistance, electrode diameter and temperature, respectively. Half values of the scale interval of the caliper (0.005 cm) and mercury thermometer (0.5 K) were chosen as absolute errors for the electrode diameter and temperature measurement. The absolute measurement error for the charge transfer resistance was determined from the equation for the direct measurement error:

$$\Delta\theta = t_{St} \cdot \sqrt{\frac{\sum_{i=1}^{12}\left(\theta_i - \bar{\theta}\right)^2}{n \cdot (n-1)}}, \qquad \text{(s2)}$$

where t_{St} is Student's coefficient, which equals 2.179 in the case of 12 measurements (n) and 0.95 confidence level; $\overline{\theta}$ is the arithmetic mean for the measurements of the charge transfer resistance; θ_i is the result of the i^{th} measurement of the charge transfer resistance.

Eq. s3 was obtained after mathematical transformations of Eq. s1 to calculate the error of indirect measurements of the apparent exchange current density.

$$\Delta i_0 = \frac{4R}{nF\theta\pi d^2}\sqrt{\left(\frac{T}{\theta}\Delta\theta\right)^2 + \left(\frac{2T}{d}\Delta d\right)^2 + (\Delta T)^2}\,. \quad \text{(s3)}$$

The measurement error for the charge transfer resistance makes the largest contribution to the measurement error Δi_0 (more than 93%). Therefore eq. s3 can be simplified by neglecting Δd and ΔT:

$$\Delta i_0 = \frac{4RT}{nF\theta^2\pi d^2}\Delta\theta. \quad \text{(s4)}$$