

Supplementary Material

Effect of Plating Variables on Oxygen Evolution Reaction of Ni-Zn-Fe Electrodes for Alkaline Water Electrolysis

Su-han Lee ^{1,2}, Ji Eun Kim ¹, Hyunku Joo ¹, Chu-sik Park ¹, Seong-uk Jeong ¹, Kwangjin Jung ¹, Young-ho Kim ² and Kyoung-soo Kang ^{1,*}

¹ Hydrogen Energy Research Center, Korea Institute of Energy Research, Daejeon 34129, Korea; lsh93046@kier.re.kr (S.-h.L.); cheeeun12@kier.re.kr (J.E.K.); hkjoo@kier.re.kr (H.J.); cspark@kier.re.kr (C.-s.P.); sujung@kier.re.kr (S.-u.J.); kjjung@kier.re.kr (K.J.)

² Department of Chemical Engineering and Applied Chemistry, Chungnam National University, Daejeon 34134, Korea; yh_kim@cnu.ac.kr

* Correspondence: kskang@kier.re.kr; Tel.: +82-42-860-3038; Fax: +82-42-860-3428

Abstract: In this study, we investigated the oxygen evolution reaction (OER) characteristics of Ni-Zn-Fe electrodes by varying plating current density and Ni:Fe ratio in a plating bath. The activity of the OER increased up to the plating current density of 160 mA/cm², as the Fe content of the deposited electrode increased and electrochemical surface area (ECSA) increased after Zn dealloying. However, for the plated electrode with higher than 160 mA/cm² of current density, the change in composition caused by underpotential deposition led to decreased activity due to decreasing Fe content and diminishing Zn dealloying. Moreover, when the Ni:Fe ratio in the plating bath was varied, outstanding OER activity was observed at Ni:Fe = 2:1. When the Fe content of the bath increased beyond this ratio, Fe could not restrain Ni oxidation and formed Fe oxides in OER reaction, and oxygen vacancy decreased. These caused a degradation of the OER activity.

Keywords: hydrogen; alkaline water electrolysis; oxygen evolution reaction

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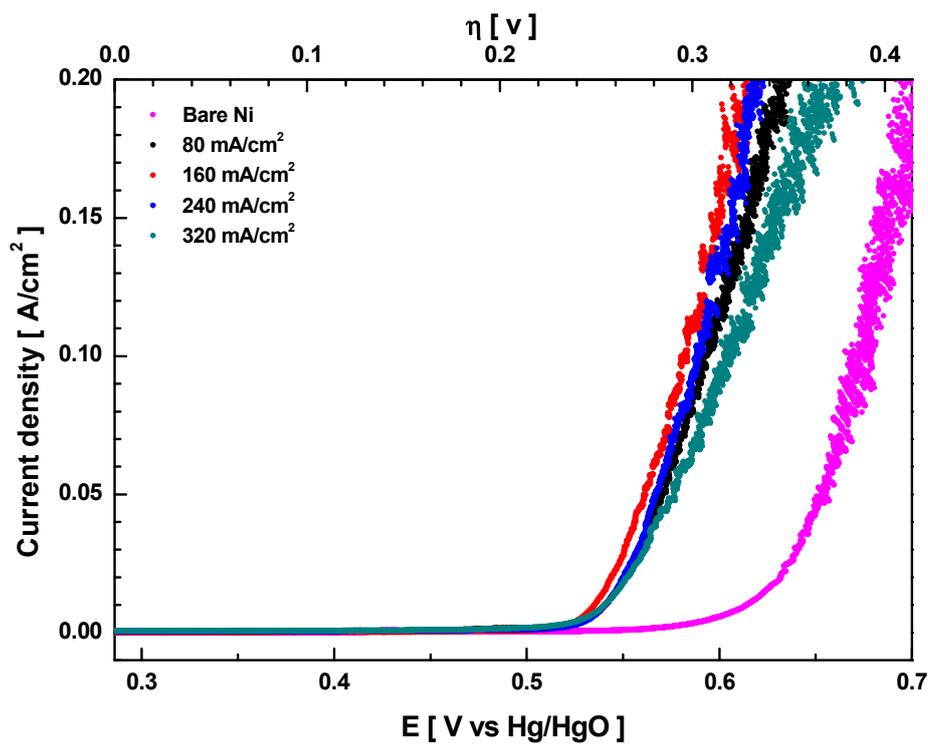


Figure S1. I-E curves (LSV) of electrodeposited Ni-Zn-Fe on Ni foam prepared with different current densities and bare Ni (Condition: scan rate = 0.1 mV/s, temperature = 25 °C, KOH = 1 M, bath = E).

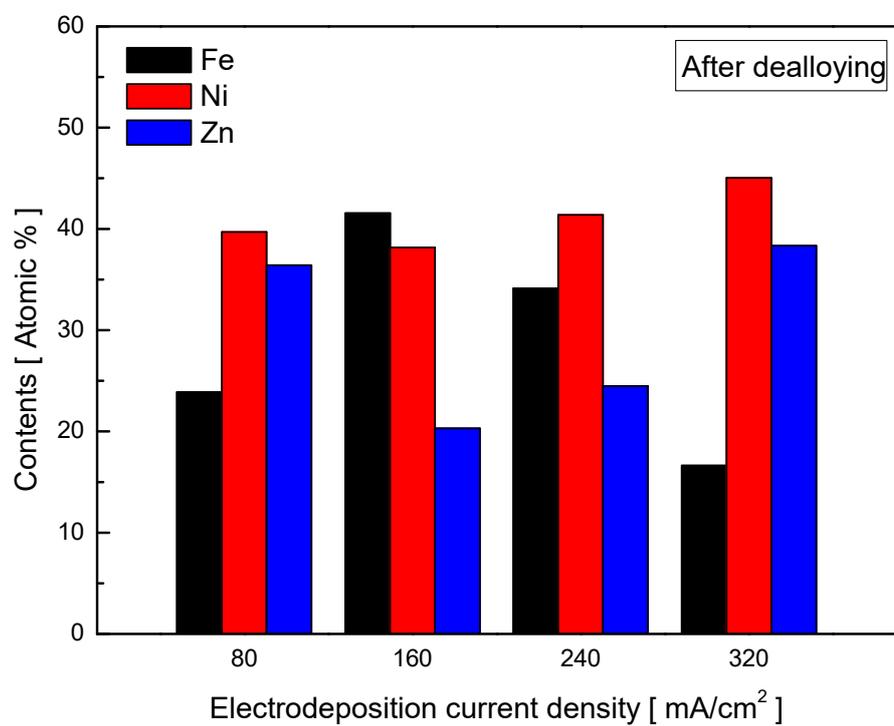


Figure S2. Composition of electrodeposited Ni Zn-Fe on Ni foam with different current densities after dealloying [atomic %] bath (E)

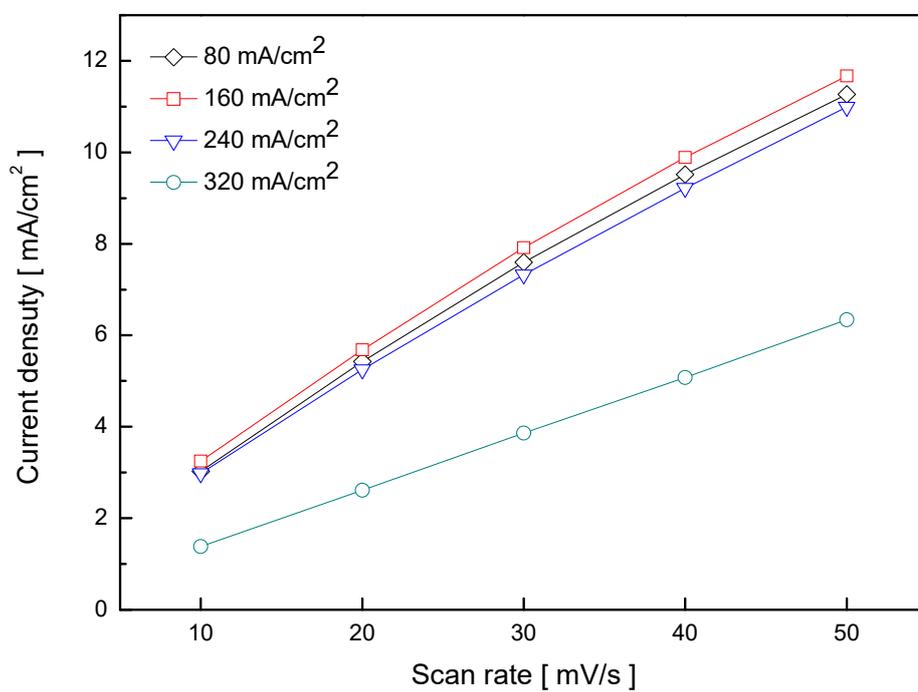


Figure S3. Plots of scan rates vs. double layer charging current density of the electrodes, electrodeposited with a varying current density of 80, 160, 240, and 320 mA/cm²

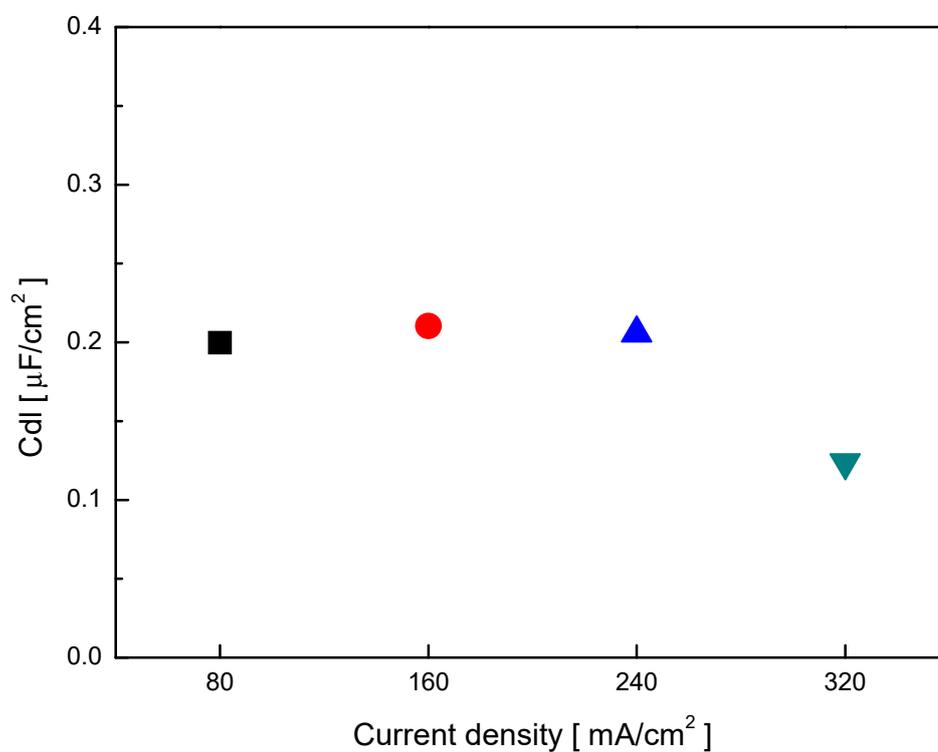


Figure S4. Electrochemical capacitance of the electrodes electrodeposited with different current densities (80, 160, 240, and 320 mA/cm²).

The electrochemical surface area (ECSA) of the electrode was calculated based on the CV result for the electrical double layer. The charging current of the double layer can be calculated based on the current obtained using CV by varying the scan rate.

$$i = \frac{dQ}{dt} = \left(\frac{dQ}{dE} \right) \cdot \left(\frac{dE}{dt} \right) = C \cdot v \quad (1)$$

where i is the current, dQ is the charge variation in the unit of C, dt is the time variation in the unit of sec, v is the scan rate, and C is the electric charging amount of the double layer.