Electronic Supplementary Information (ESI) for

Tuning the Oxygen Reduction Activity of the Pt-Ni Nanoparticles under Specific Anion Adsorption by Varying Heat Treatment Atmosphere

Young-Hoon Chung\textsuperscript{a,b}, Soo Jin Kim\textsuperscript{b}, Dong-Young Chung\textsuperscript{a,c}, Myung Jae Lee\textsuperscript{a,c}, Jong Hyun Jang\textsuperscript{b,*},
and Yung-Eun Sung\textsuperscript{a,c,*}

\textsuperscript{a}School of Chemical and Biological Engineering, Seoul National University (SNU), Seoul, 151-742, Republic of Korea

\textsuperscript{b}Fuel Cell Research Center, Korea Institute of Science and Technology (KIST), Seoul, 136-791, Republic of Korea

\textsuperscript{c}Center for Nanoparticle Research, Institute of Basic Science (IBS), Seoul, 151-742, Republic of Korea

* Corresponding author: E-mail address: ysung@snu.ac.kr (Y.-E. Sung) and jhjang@kist.re.kr (J. H. Jang)

Tel.: +82-2-880-1889, Fax: +82-2-880-1604
S1. Supplementary Half-Cell Data

S1.1. Cyclic voltamograms of Pt and PtNi nanoparticles

Fig. S1. Cyclic voltamograms (CVs) of Pt, PtNi_Ar, PtNi_H2, and PtNi_Air nanoparticles in (a) 0.1 M HClO₄ and (b) 0.1 M HClO₄ + 0.1 M H₃PO₄; and (c) CVs of PtNi_AP in 0.1 M HClO₄ after potential cycling. All measurements were carried out at 20 °C in saturated Ar condition (99.999%).

S1.2. Kinetic current density
S2. Kinetic current density of Pt, PtNi_Ar, PtNi_H2, and PtNi_Air nanoparticles in 0.1 M HClO₄ (left) and 0.1 M HClO₄ + 0.1 M H₃PO₄ (Right).

S2. XPS Spectra of Pt 4f and Ni 2p

Fig. S3. XPS spectra of PtNi_Ar (left), PtNi_H2 (middle), and PtNi_Air (right) nanoparticles for Pt 4f.
Fig. S4. XPS spectra of PtNi_Ar (left), PtNi_H2 (middle), and PtNi_Air (right) nanoparticles for Ni 2p.

Table S1. Deconvolution results from XPS spectra of Pt 4f and Ni 2p.

<table>
<thead>
<tr>
<th>Area Ratio (%)</th>
<th>Pt 4f</th>
<th>Ni 2p</th>
<th>$x^{*}_{\text{PtNi}_x}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pt(0)</td>
<td>Pt(I)</td>
<td>Pt(IV)</td>
</tr>
<tr>
<td>PtNi_Ar</td>
<td>52.4</td>
<td>33.4</td>
<td>14.2</td>
</tr>
<tr>
<td>PtNi_H2</td>
<td>56.6</td>
<td>23.9</td>
<td>19.5</td>
</tr>
<tr>
<td>PtNi_Air</td>
<td>33.0</td>
<td>36.1</td>
<td>30.9</td>
</tr>
</tbody>
</table>
S3. Supplementary Single-Cell Data

S3.1. Polarization curves of Pt and PtNi_Ar under air feed

Fig. S5. (a) Polarization curve for Pt(HiSpec 4000, 40 wt%, 0.78 mg\text{Pt}\text{cm}^{-2}) and PtNi_Ar(40 wt%, 0.6 mg\text{Pt}\text{cm}^{-2}) as cathode catalysts (anode catalyst 1.0 mg\text{Pt}\text{cm}^{-2}). The feed gas to cathode is non-humidified air (stoichiometry 2) and cell temperature is 160°C. (b) Comparison of current density normalized with respect to platinum weight at 0.6V. (c) Tafel plot and (d) kinetic current density normalized with respect to platinum weight at 0.7 V
S3.2. Durability test of PtNi_Ar nanoparticles

**Fig. S6.** Voltage at 0.2 A/cm² for Pt (40 wt%, 0.78 mgPt cm⁻²) and PtNi_Ar (40 wt%, 0.6 mgPt cm⁻²) as cathode catalysts (anode catalyst 1.0 mgPt cm⁻²). The feed gas to cathode is non-humidified air(stoichiometry 2) and cell temperature is 160°C.
S4. Supplementary TEM Images

Fig. S7. TEM image of as-prepared Pt$_1$Ni$_{12}$/C.

Fig. S8. High resolution-TEM image of the PtNi$_{Ar}$.
S5. UV-vis Spectra

**Fig S9.** UV-vis spectra of PtCl$_4$ solution in the ethanol before (black)/after (red) the addition of the reducing agent (NaBH$_4$).