Supplementary information for

Nanostructured robust cobalt metal alloy based anode electro-catalysts exhibiting remarkably high performance and durability for proton exchange membrane fuel cells

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This is an abstract presented at the 225th Electrochemical Society Meeting in Orlando, FL (May 11-15, 2014).
Figure S1: Method of multiple small potential steps used on the RDE to reduce the contribution by charging current and current measurement that was performed at the end of each step.
Figure S2: The bright field TEM image of Ir NPs showing the presence of fine nanoparticles with HRTEM image showing lattice fringes with a spacing of ~0.22 nm.
Figure S3: The cyclic voltammetry (CV) curve for HOR of Ir-NPs and Pt/C, measured in H$_2$ saturated 0.5 M H$_2$SO$_4$ electrolyte solution at 40°C at scan rate of 10 mV/sec.
**Figure S4:** Tafel polarization plot of Ir NPs, before and after $iR_\Omega$ correction.
Figure S5: Tafel polarization plot of Pt/C, before and after $iR_\Omega$ correction.
Figure S6: The bright field TEM image of Co$_{0.7}$(Ir$_{0.3}$) showing the presence of fine nanoparticles and the particle size distribution with the HRTEM inset image showing lattice fringes with a spacing of ~0.213 nm.
Figure S7: SEM micrograph and the corresponding elemental mapping, and EDAX spectrum of 
Co$_{0.8}$(Ir$_{0.2}$) collected from the solid solution nanoparticles.
Figure S8: SEM micrograph and the corresponding elemental map and EDAX spectrum of Co$_{0.7}$(Ir$_{0.3}$) collected from the solid solution alloy nanoparticles.
Figure S9: SEM micrograph and the corresponding elemental map and EDAX spectrum of Ir collected from the Ir nanoparticles.
Figure S10: The cyclic voltammetry (CV) curve for HOR of Co$_{1-x}$(Ir$_x$) (x=0.2, 0.3, 0.4), measured in H$_2$ saturated 0.5 M H$_2$SO$_4$ electrolyte solution at 40°C at scan rate of 10 mV/sec
Figure S11: Tafel polarization plot of Co$_{0.8}$(Ir$_{0.2}$), before and after iR$_{\Omega}$ correction.

Figure S12: Tafel polarization plot of Co$_{0.7}$(Ir$_{0.3}$), before and after iR$_{\Omega}$ correction.
Figure S13: Tafel polarization plot of Co$_{0.6}$(Ir$_{0.4}$), before and after $iR_\Omega$ correction.
Figure S14: The polarization curve for HOR of Co$_{0.8}$(Ir$_{0.2}$) obtained on rotating disk electrode (RDE), measured in H$_2$ saturated 0.5 M H$_2$SO$_4$ electrolyte solution at 40°C with a scan rate of 10 mV/sec. Koutechy-Levich plot obtained for Co$_{0.8}$(Ir$_{0.2}$) is shown in the inset of the polarization curve.
**Figure S15:** The polarization curve for HOR of Co$_{0.7}$(Ir$_{0.3}$) obtained on rotating disk electrode (RDE), measured in H$_2$ saturated 0.5 M H$_2$SO$_4$ electrolyte solution at 40°C with a scan rate of 10 mV/sec. Koutechy-Levich plot obtained for Co$_{0.7}$(Ir$_{0.3}$) is shown in the inset of the polarization curve.
**Figure S16:** The polarization curve for HOR of Ir-NPs obtained on rotating disk electrode (RDE), measured in H$_2$ saturated 0.5 M H$_2$SO$_4$ electrolyte solution at 40°C with a scan rate of 10 mV/sec. Koutechy-Levich plot obtained for Ir is shown in the inset of the polarization curve.
Figure S17: The polarization curve for HOR of Pt/C obtained on rotating disk electrode (RDE), measured in H₂ saturated 0.5 M H₂SO₄ electrolyte solution at 40°C with a scan rate of 10 mV/sec. Koutechy-Levich plot obtained for Pt/C is shown in the inset of the polarization curve.
Figure S18: The cyclic voltammetry (CV) curve obtained for Ir-NPs and Pt/C, measured in N₂ saturated 0.5 M H₂SO₄ electrolyte solution at 40°C collected at a scan rate of 10 mV/sec.
Figure S19: The cyclic voltammetry (CV) curve of Co$_{1-x}$(Ir$_x$) (x=0.2, 0.3, 0.4), measured in N$_2$ saturated 0.5 M H$_2$SO$_4$ electrolyte solution at 40°C at scan rate of 10 mV/sec.