[1]**Supplementary Information for**

Are We Underrating Rare-Earth as an Electrocatalyst?- The Effect of their Substitution in Palladium Nanoparticles Enhances the Activity towards Ethanol Oxidation Reaction

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Tables

Table S1. The table shown lists the particle size of the catalysts determined from Scherrer's equation.

Catalyst	FWHM	Theta (in angle)	cos (theta)	Particle Size (nm)
YbPd	0.26492	20.046	0.939371629	31.9
EuPd	0.22503	20.043	0.939389589	37.6
NiPd	0.22532	20.118	0.93893982	37.5
CrPd	0.341662	20.018	0.939539154	24.7
YbPt	0.38209	19.8865	0.940322919	22.1
EuPt	0.37139	19.798	0.940847606	22.7

Table S2. The table shown lists the average atomic percentage and average weight percentage of the catalyst obtained from the EDAX measurements.

Catalyst	Average At %	Average Wt%
YbPd	Yb=7.4%, Pd=92.6%	Yb=11.5%, Pd=88.5%
EuPd	Eu=12.6%, Pd=87.4%	Eu=16.1%, Pd=83.9%
YbPt	Yb=11.7%, Pt=88.3%	Yb=10.5%, Pt=89.5%
EuPt	Eu=10.8%, Pt=89.2%	Eu=8.6%, Pt=91.4%
NiPd	Ni=11.2%, Pd=88.8%	Ni=6.5%, Pd=93.5%
CrPd	Cr=7.1%, Pd=92.9%	Cr=3.5%, Pd=96.5%

Table S3. The table shown lists the average weight percentage of the catalyst obtained from the ICP-OES measurements.

Catalyst	Composition	
	RE/TM	**Pd**
YbPd	11.2	88.8
EuPd	14.8	85.2
NiPd	16.7	83.3
CrPd	13.5	86.5

Table S4. The table shown lists the ECSA value of the catalyst normalized with respect to Pd loading.

Catalysts	EASA (m^2/gm_{Pd})
Pd/C (20 wt%)	66.2
YbPd	11.4

EuPd	13.5
NiPd	13.3
CrPd	1.57

Table S5. *d*-band center of the catalyst, with adsorbed intermediates, as a descriptor for strength of adsorption of intermediates. The value in parenthesis denoted the *d*-band center of the catalyst before the adsorption of intermediates.

Catalysts	**$COCH_3$ (eV)**	**OH (eV)**
Pd (111)	-3.15 (-2.14)	-2.76 (-2.14)
YbPd	-2.83 (-2.19)	-2.91 (-2.88)
NiPd	-2.79 (-2.59)	-2.69 (-2.31)
CrPd	-2.94 (-2.29)	-2.38 (-1.95)

Figures

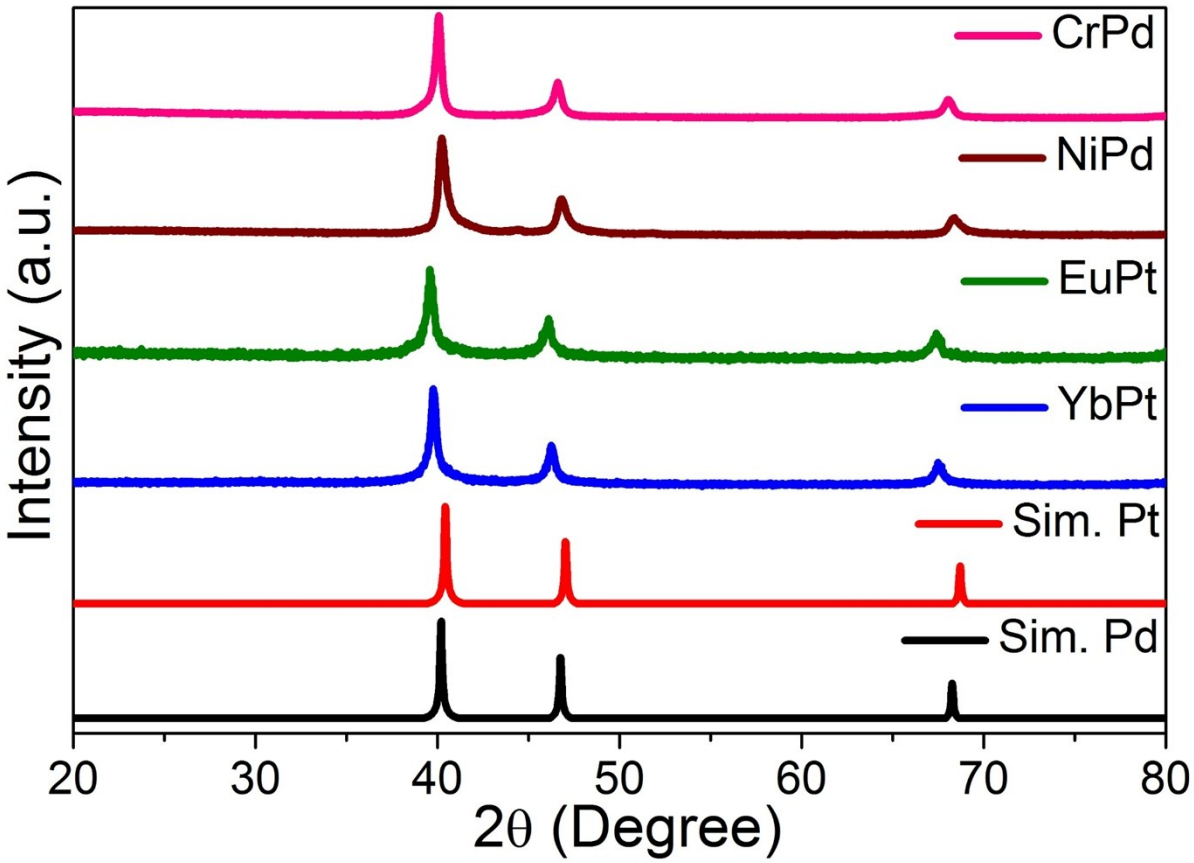

Figure S1. Comparison of experimental PXRD pattern of CrPd, NiPd, EuPt, YbPt with simulated patterns of Pd and Pt.

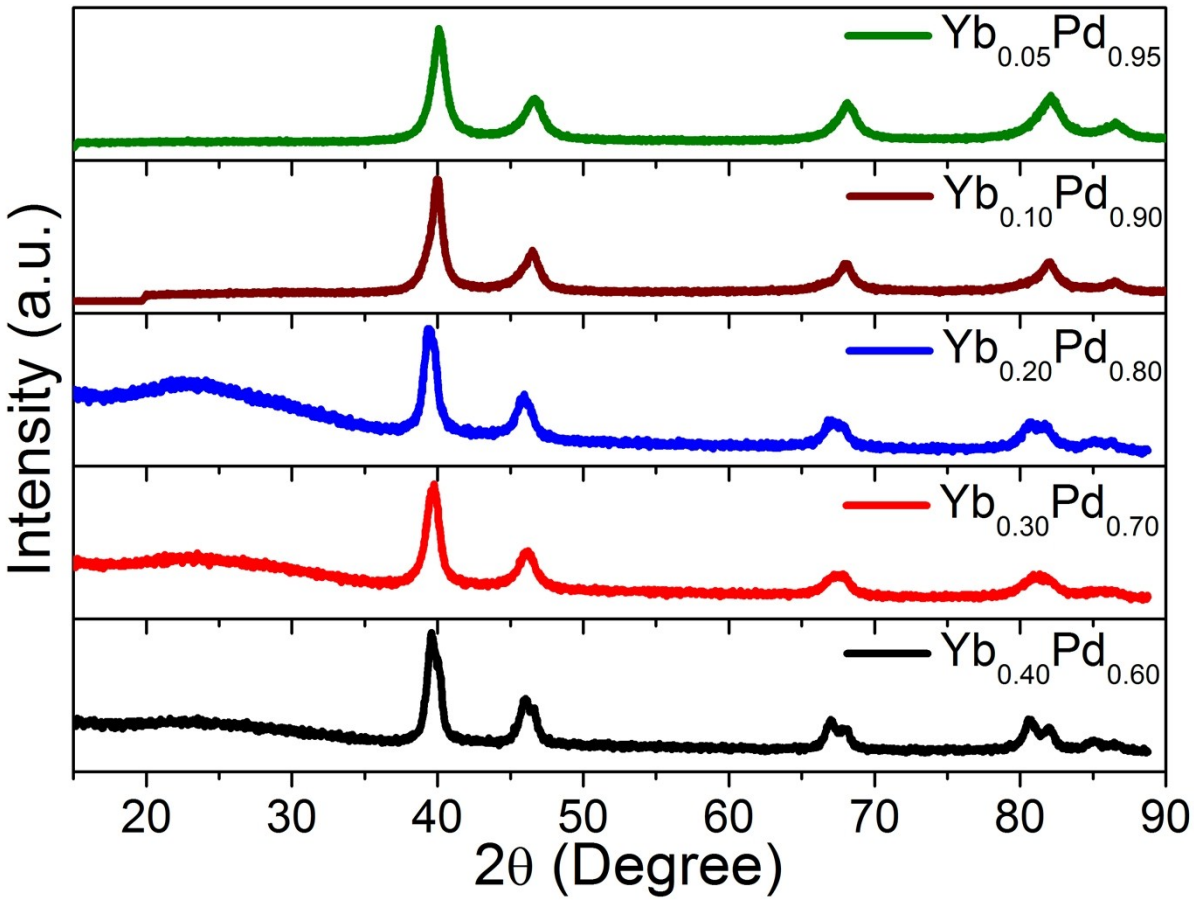

Figure S2. Comparison of the PXRD pattern of $Yb_{0.05}Pd_{0.95}$, $Yb_{0.10}Pd_{0.90}$, $Yb_{0.20}Pd_{0.80}$, $Yb_{0.30}Pd_{0.70}$ and $Yb_{0.40}Pd_{0.60}$.

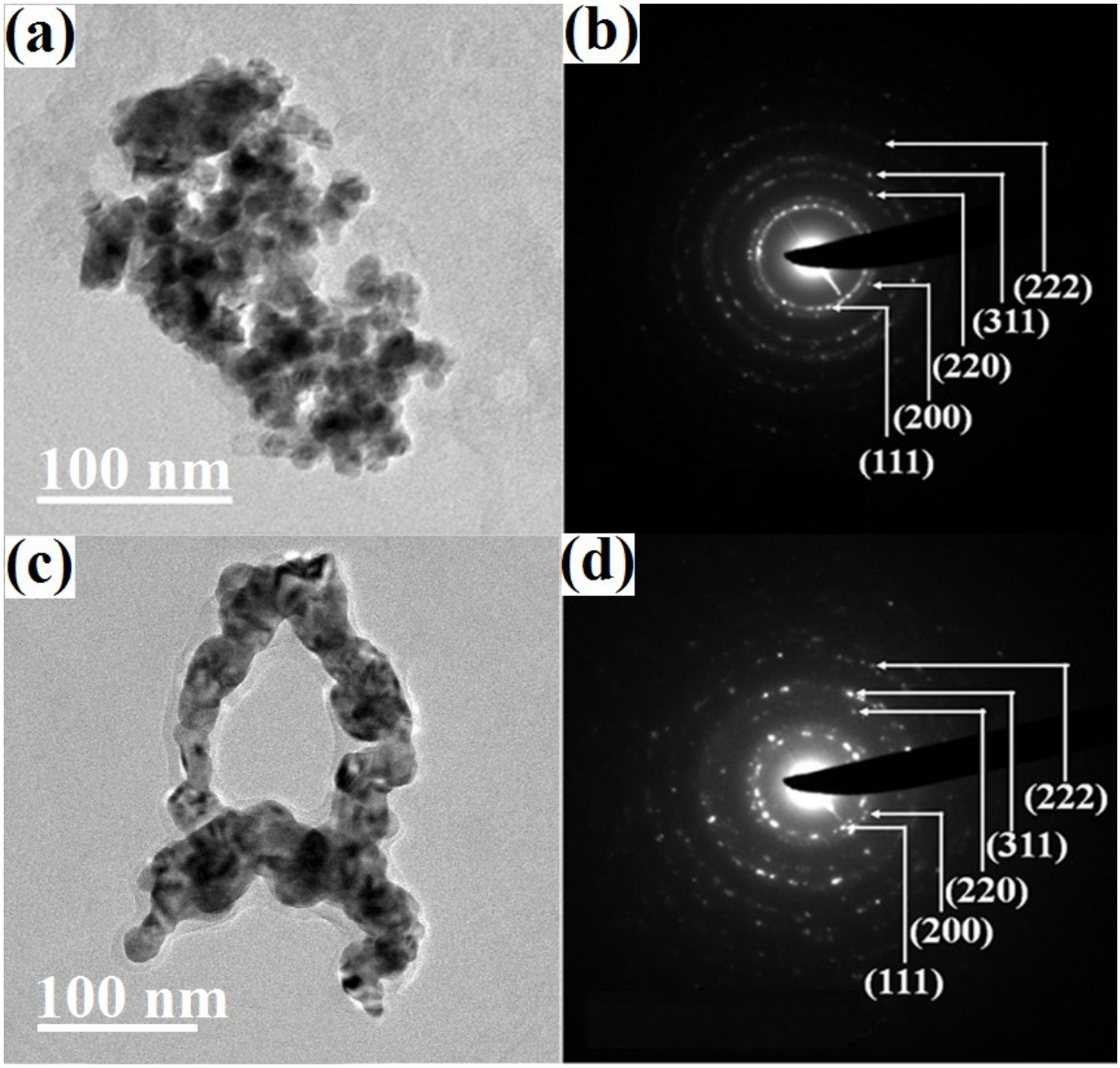

Figure S3. TEM images of (a) CrPd and (c) NiPd and corresponding SAED pattern of (b) CrPd and (d) NiPd.

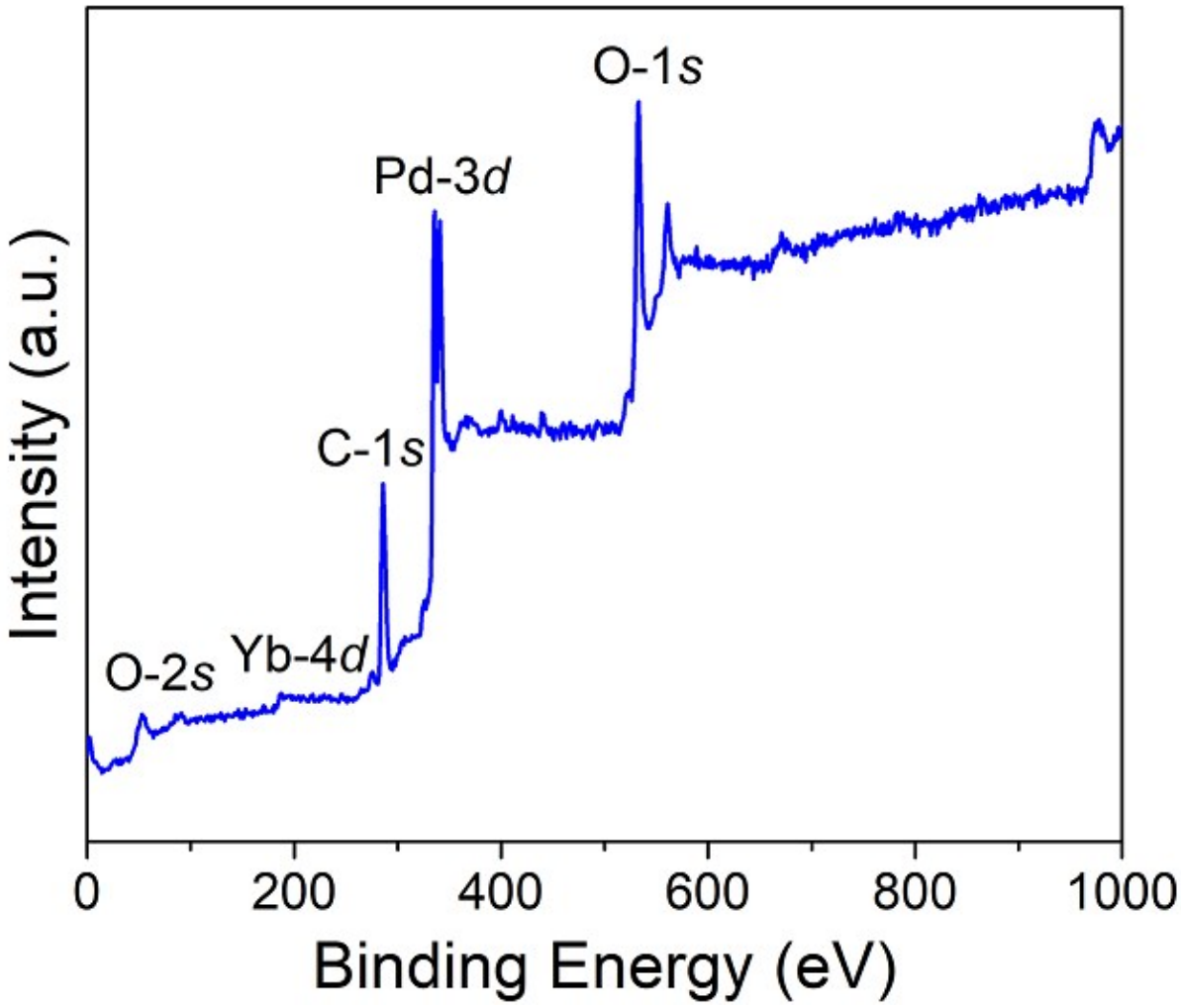

Figure S4. Survey XPS spectra of YbPd showing the presence of Yb, Pd and O and absence of Cl.

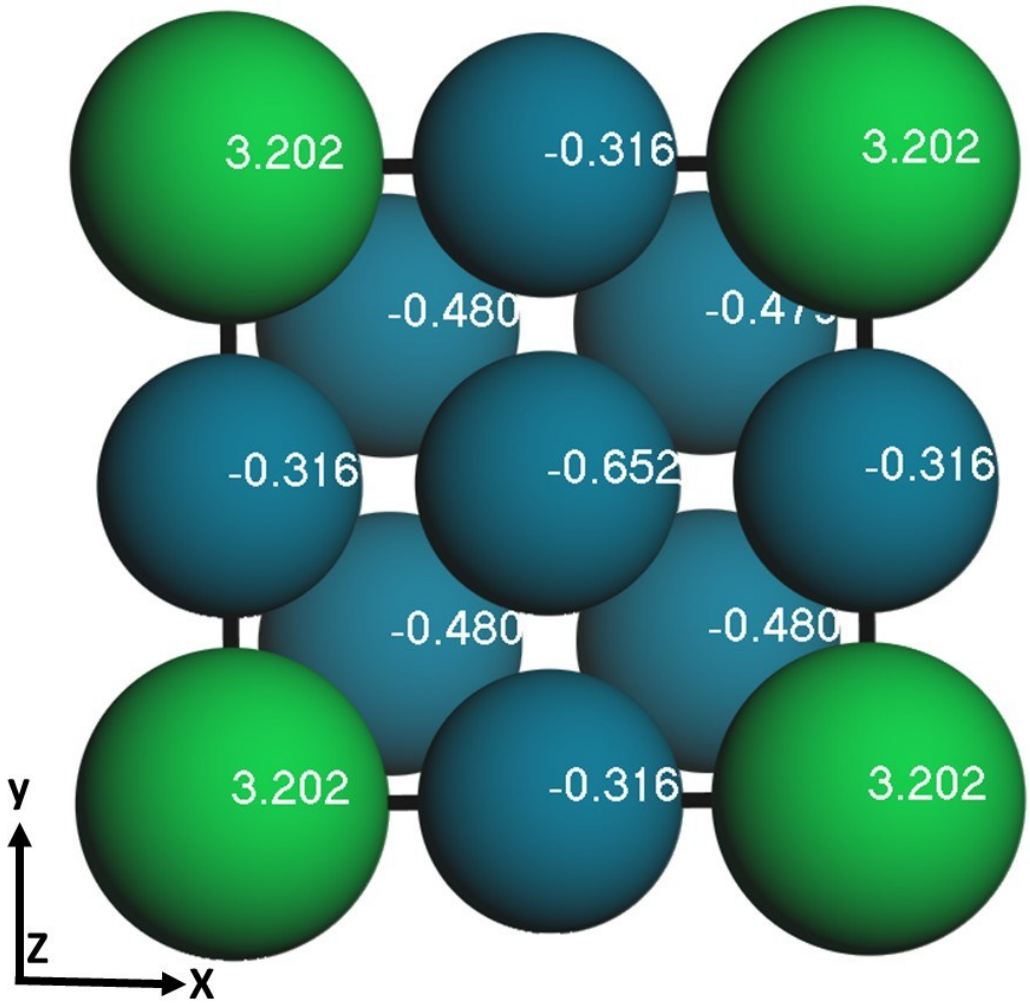

Figure S5. Mulliken charge analysis showing approximately +3 and -0.3 oxidation states of Yb and Pd, respectively. Text on each atom indicates the corresponding charge on the atom. Green and blue atoms corresponds to Yb and Pd, repectively.

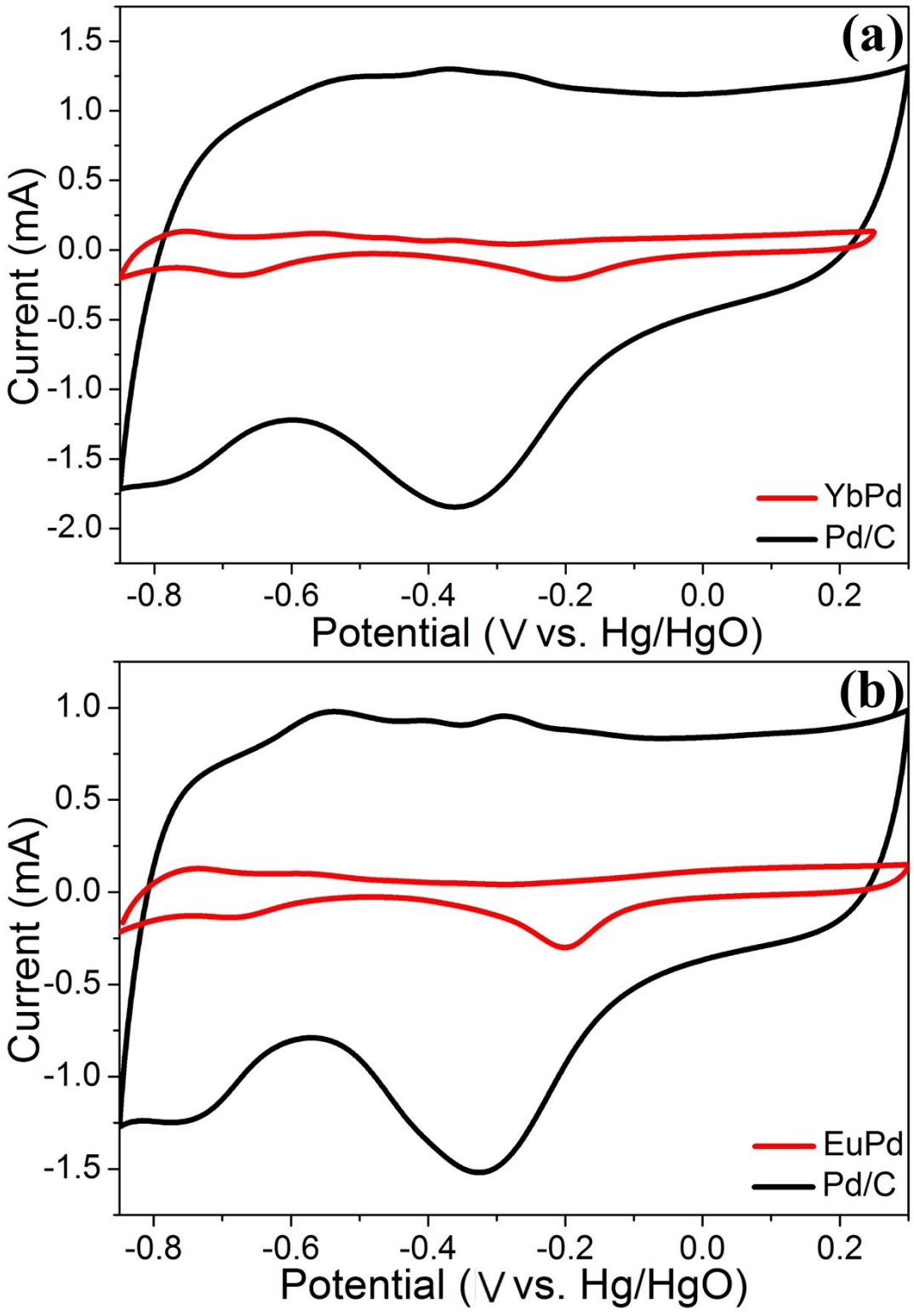

Figure S6. The comparison of the cyclic voltammagram of (a) YbPd and (b) EuPd in N_2 saturated 0.5 M KOH measured at a sweep rate of 50 mV/sec with commercially available Pd/C (20 wt%).

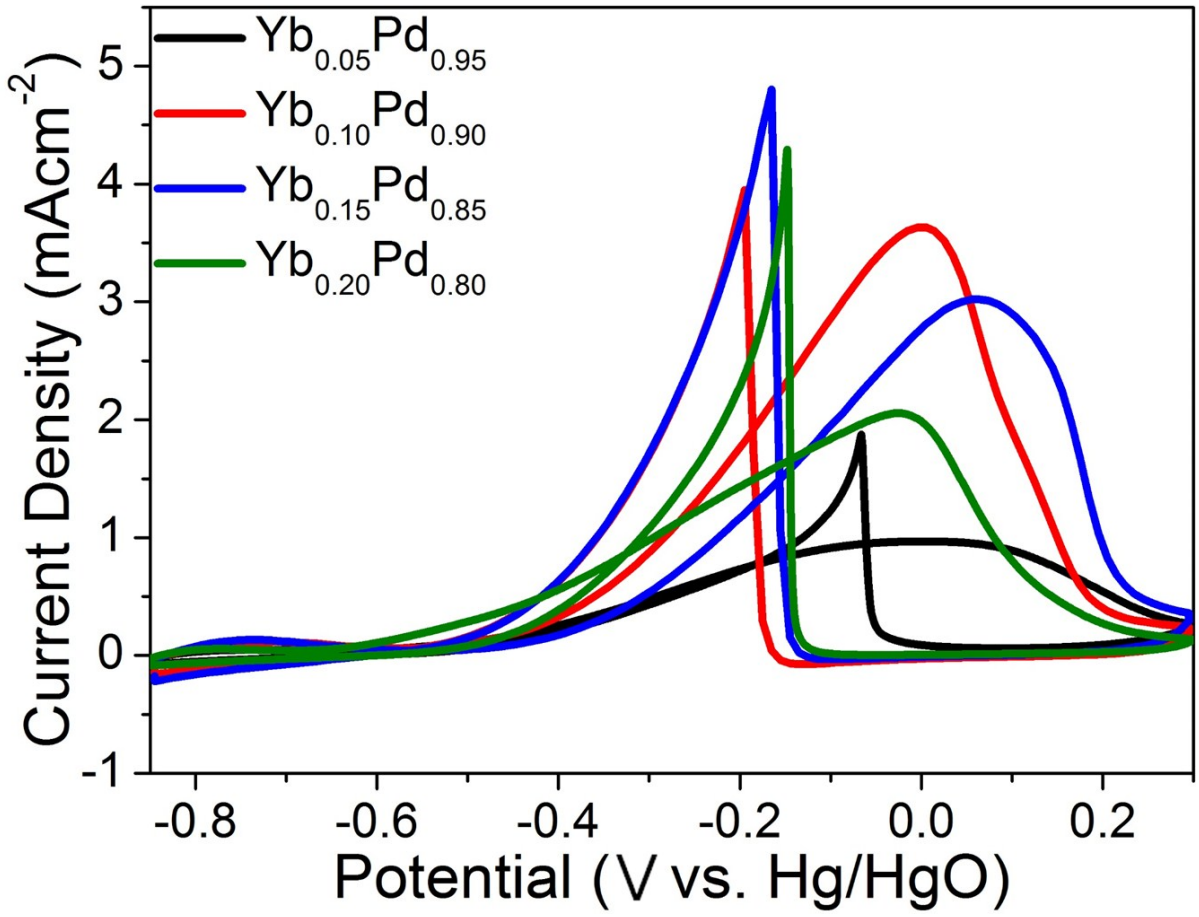

Figure S7. The comparison of the EOR specific activity of $Yb_{0.05}Pd_{0.95}$, $Yb_{0.10}Pd_{0.90}$, $Yb_{0.15}Pd_{0.95}$ and $Yb_{0.20}Pd_{0.80}$ in N_2 saturated 0.5 M KOH measured at a sweep rate of 50 mV/sec.

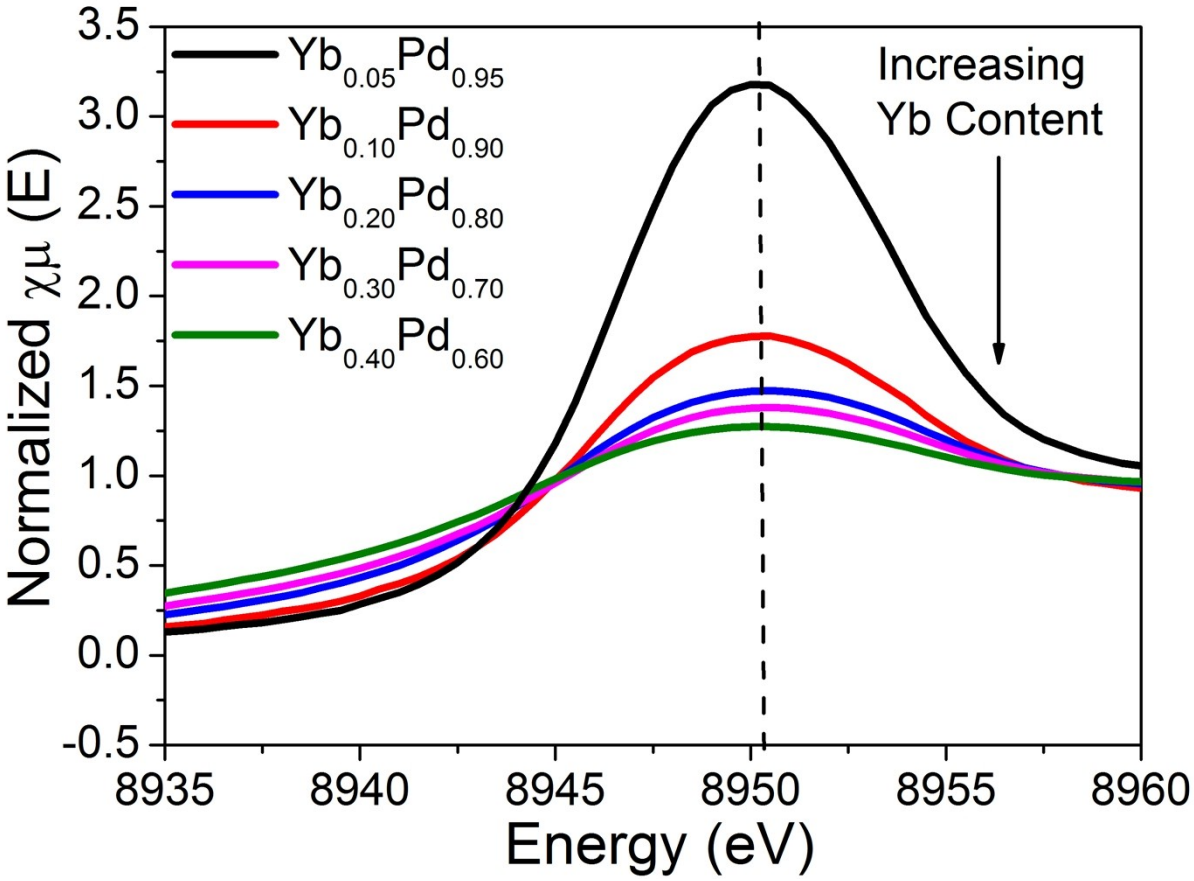

Figure S8. Comparison of white line intensity of $Yb_{0.05}Pd_{0.95}$, $Yb_{0.10}Pd_{0.90}$, $Yb_{0.20}Pd_{0.80}$, $Yb_{0.30}Pd_{0.70}$ and $Yb_{0.40}Pd_{0.60}$ measured at Yb L_{III} edge.