Electronic Supplementary Material (ESI) for RSC Advances.

Pronounced effect of yttrium oxide on the activity of Pd/rGO electrocatalyst for formic acid oxidation reaction

Muhammad Sofian,[1] Fatima Nasim,[1] Hassan Ali,[1]* Muhammad Arif Nadeem [1,2]*

[1]Catalysis and Nanomaterials Lab 27, Department of Chemistry, Quaid-i-Azam University, Islamabad 45320, Pakistan

[2]Pakistan Academy of Sciences, 3-Constitution Avenue Sector G-5/2, Islamabad, Pakistan.

*Contact details:

M.A.N; manadeem@qau.edu.pk;

H.A.; hassanali471@gmail.com

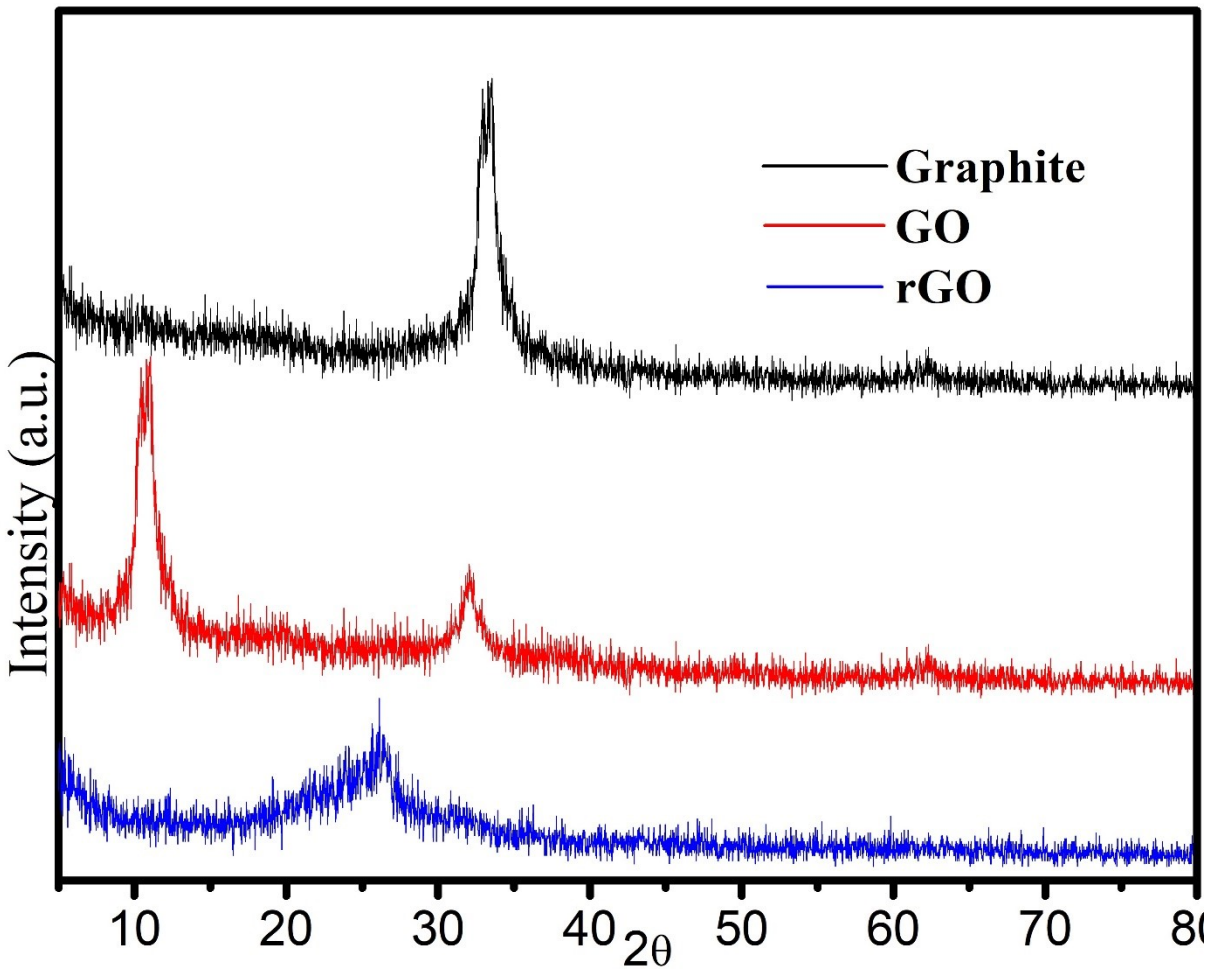

Figure S1. PXRD pattern of graphite, graphene oxide (GO) and reduced graphene oxide (rGO)

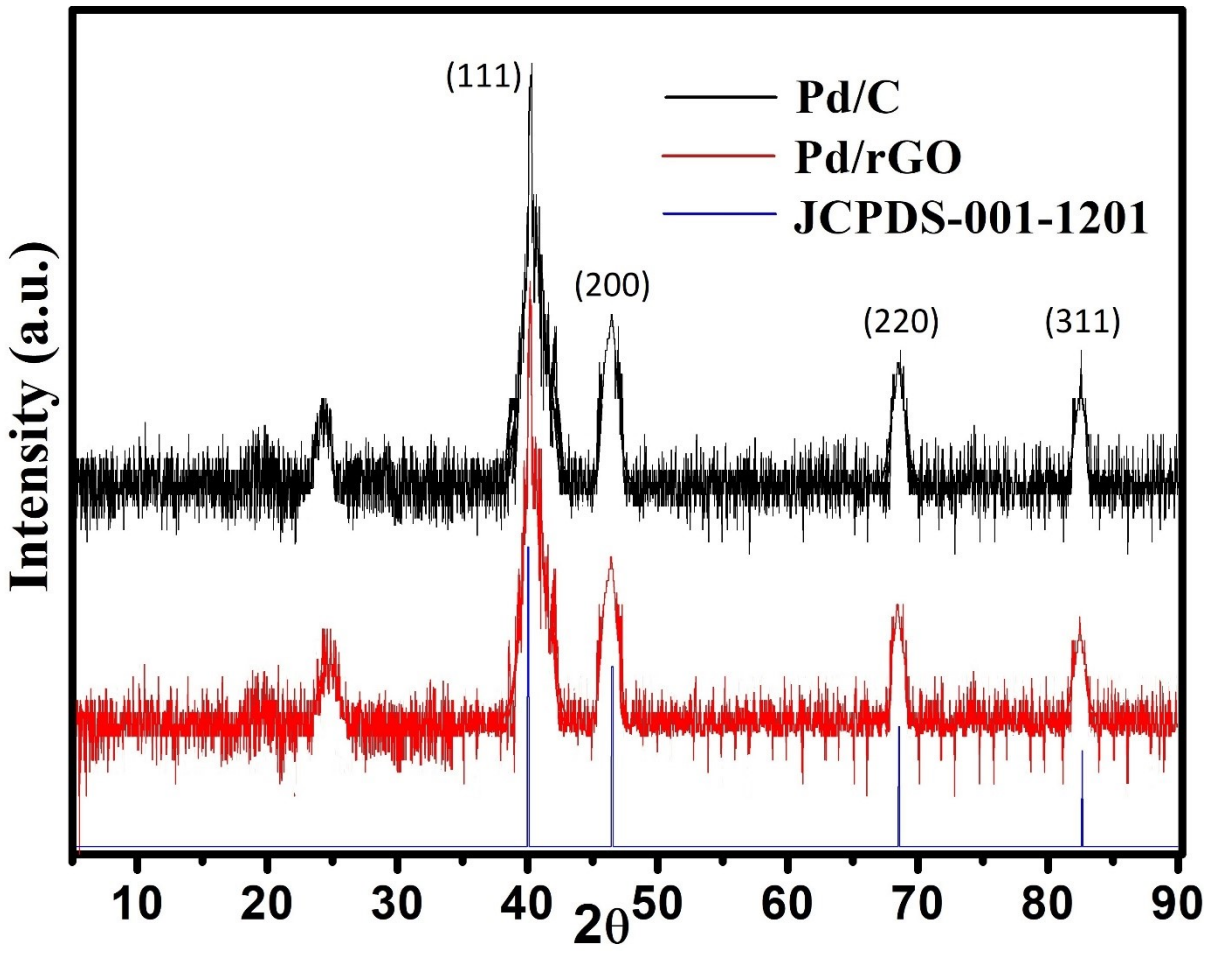

Figure S2. PXRD pattern of Pd with reference catalysts (Pd/rGO and Pd/C)

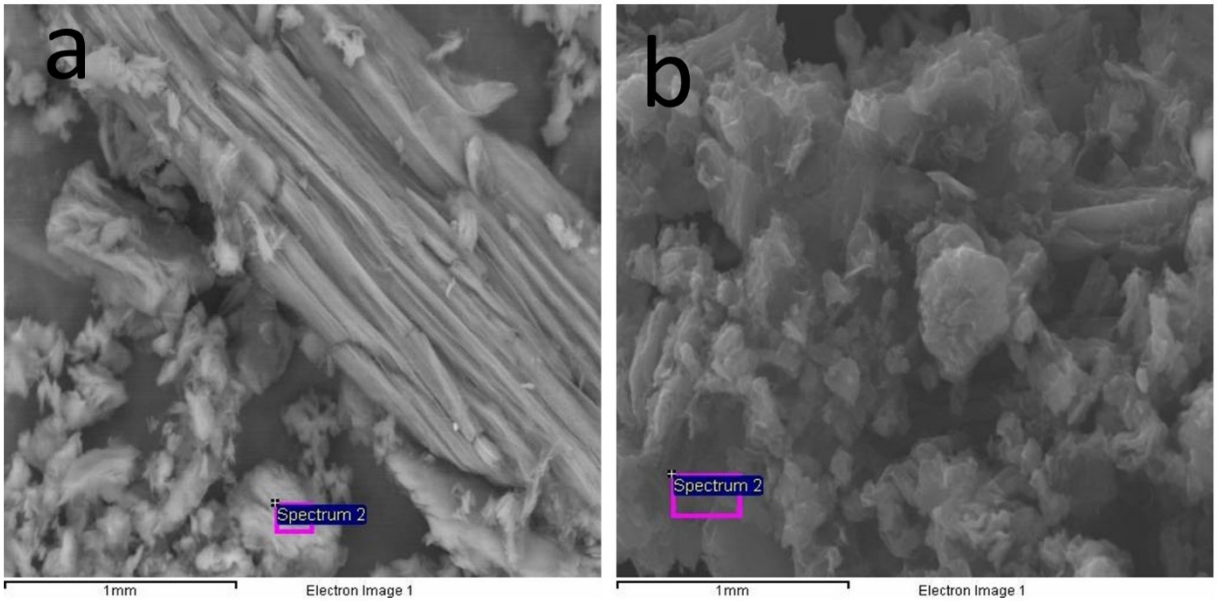

Figure S3. SEM Images of rGO (a) layered view (b) surface view

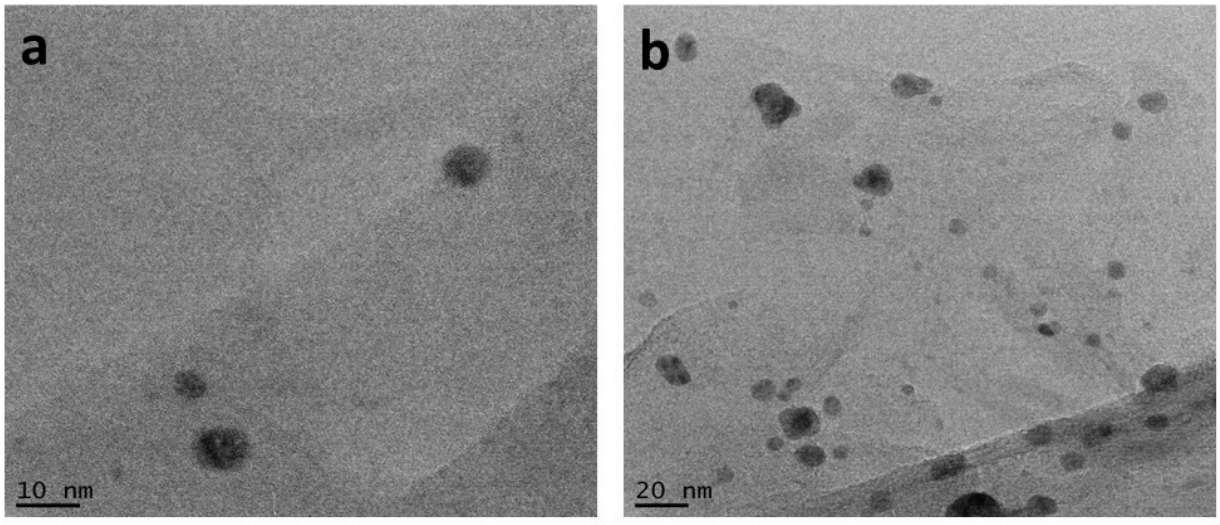

Figure S4. TEM of Pd_6Y_4/rGO at 10 and 20 nm

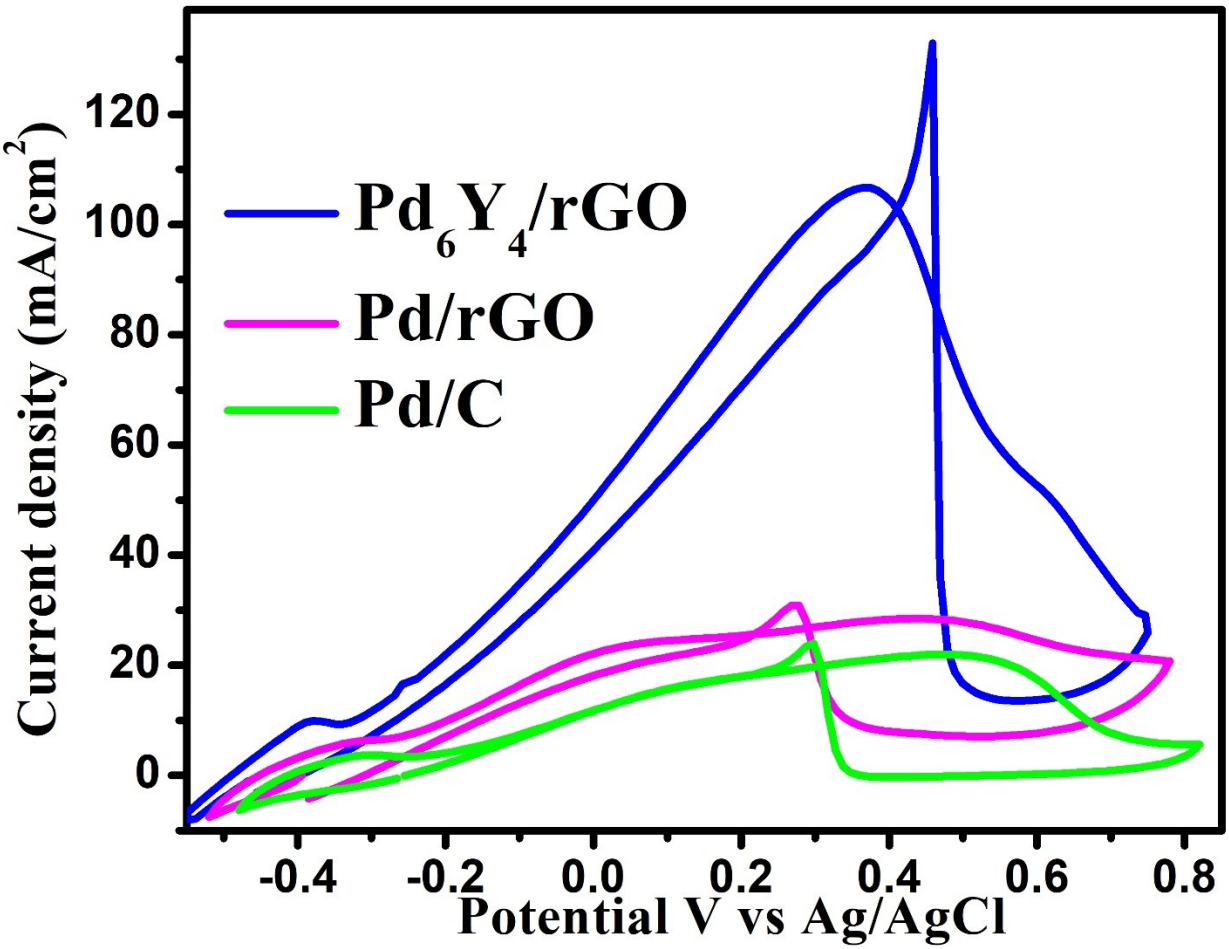

Figure S5. Current density of Pd_6Y_4/rGO and reference catalysts (Pd/rGO and Pd/C)

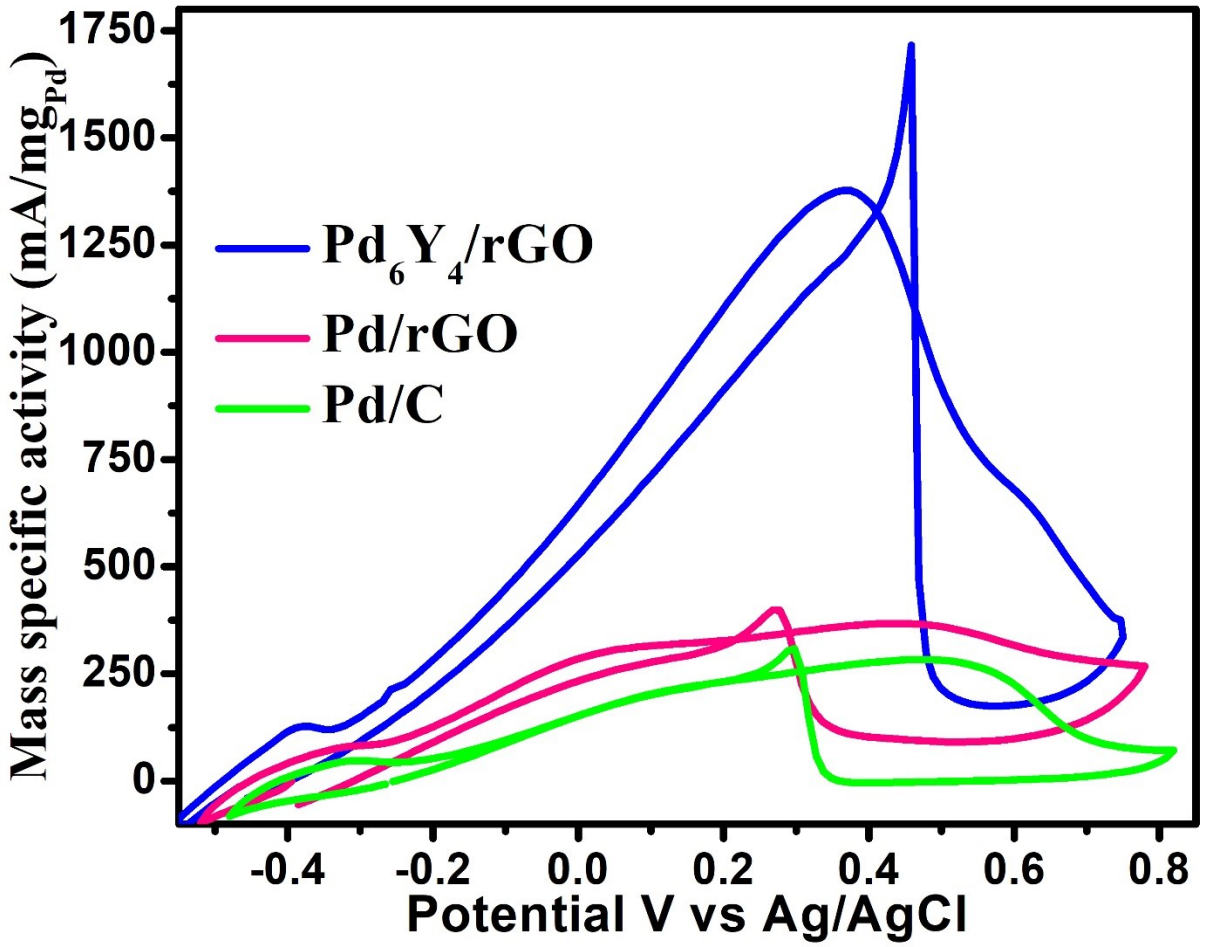

Figure S6. Mass specific activity of Pd_6Y_4/rGO and reference catalysts (Pd/rGO and Pd/C)

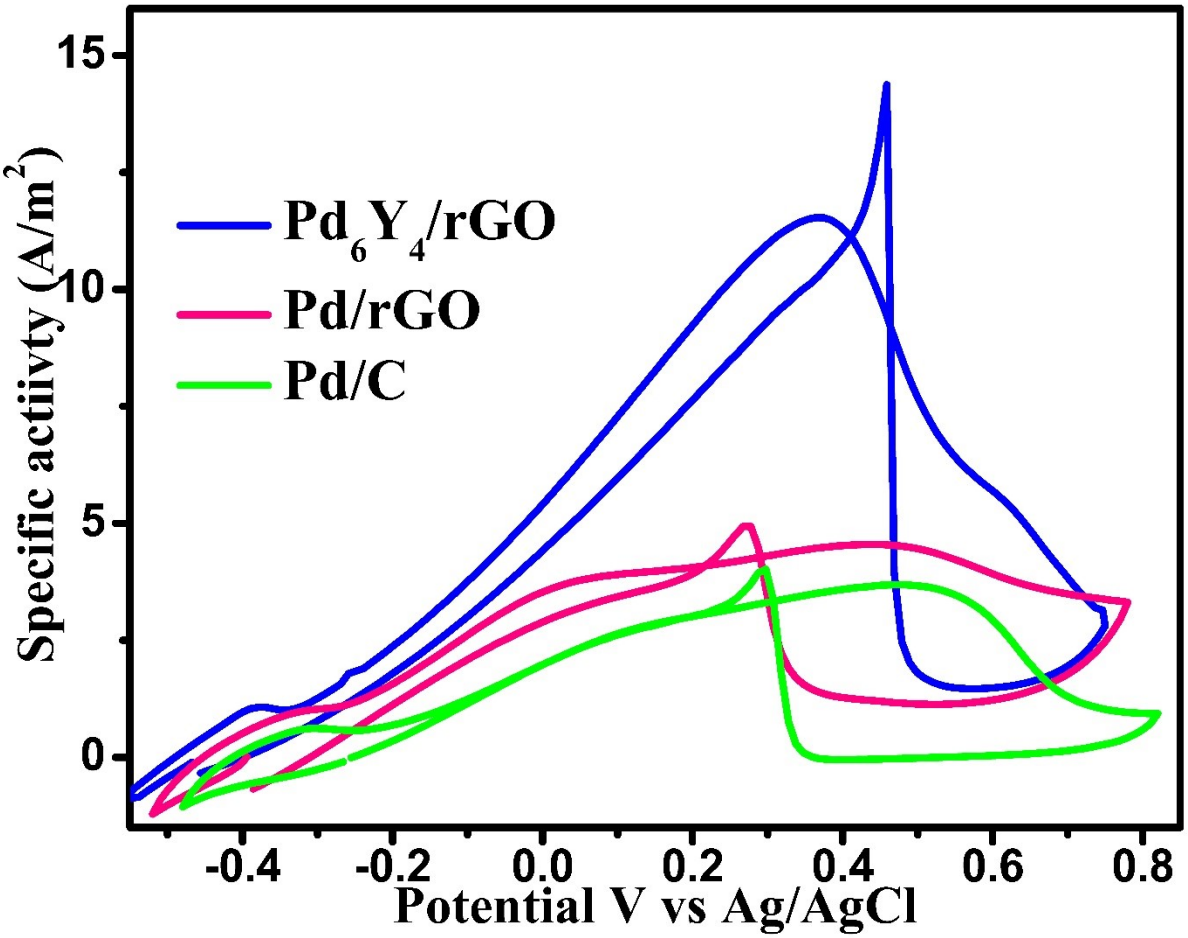

Figure S7. Specific activity of Pd_6Y_4/rGO and reference catalysts (Pd/rGO and Pd/C)

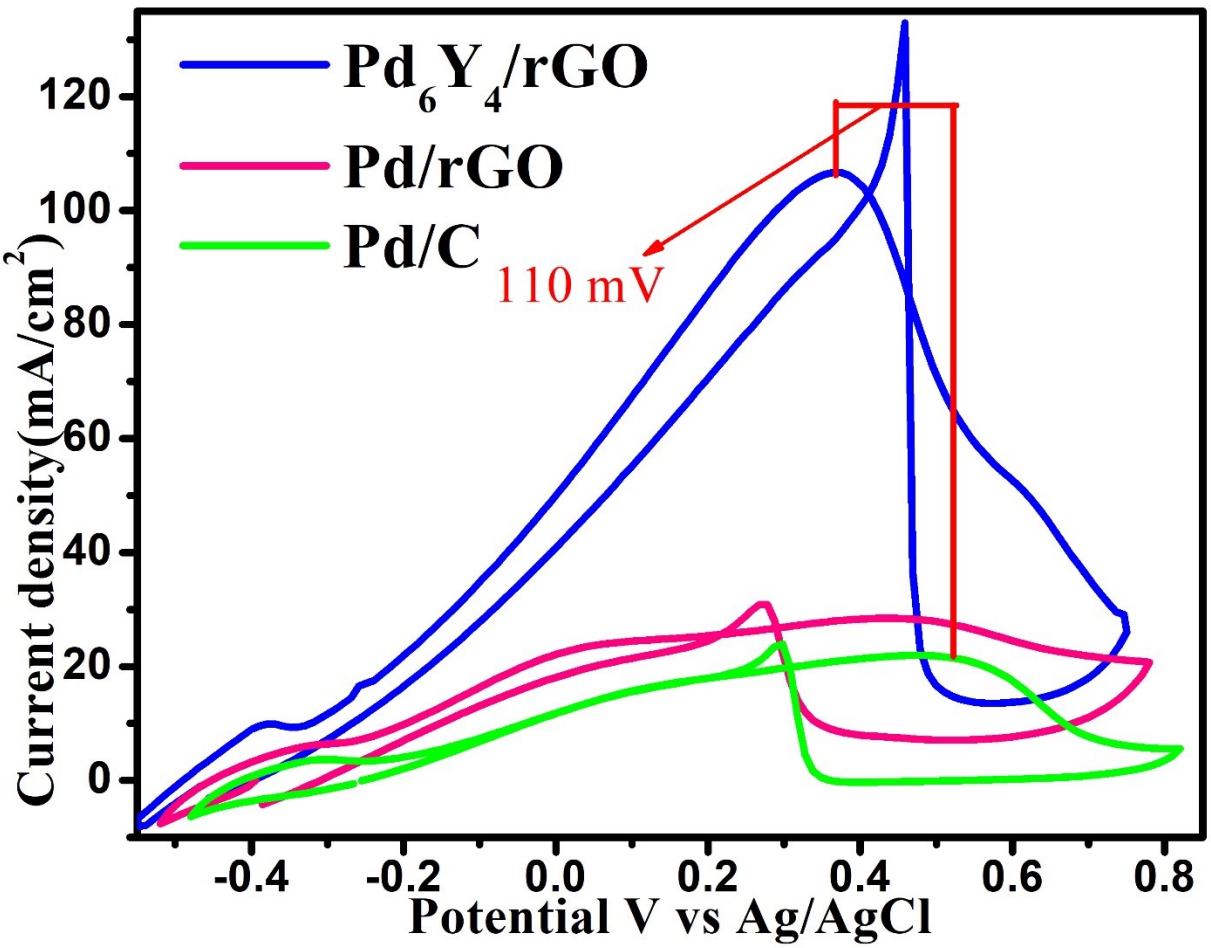

Figure S8. Shift of oxidation peak potential of Pd_6Y_4/rGO in comparison to reference catalysts (Pd/rGO and Pd/C)

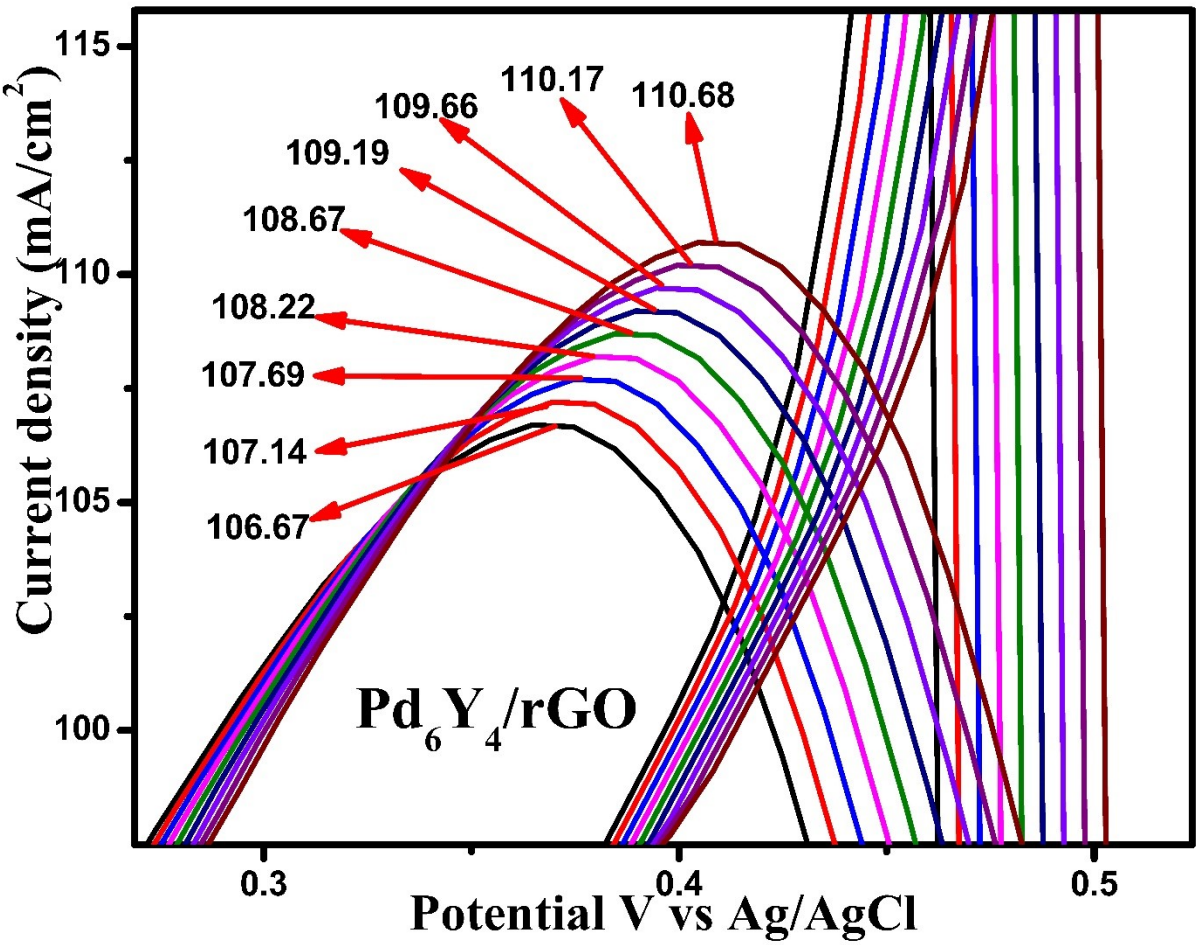

Figure S9. Current density relation of Pd_6Y_4/rGO with scan rate

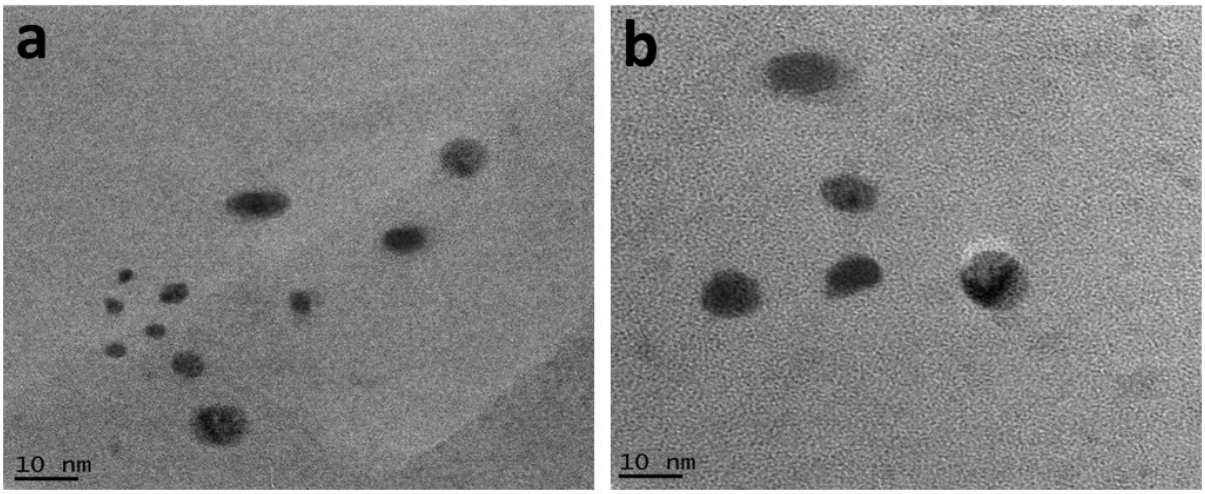

Figure S10. TEM image of (a) Pd_2Y_8/rGO (b) Pd_4Y_6/rGO

Table S1. Comparison of various electrochemical parameters of synthesized materials

Catalyst	ECSA (m^2/g)	E_f (V)	E_b(V)	j_f (mA/cm^2)	j_b (mA/cm^2)	MSA (mA/mg_{Pd})	SA (A/m^2)	R_{ct} (Ω)
Pd_6Y_4/rGO	119.4	0.36	0.45	106.60	132.54	1380	11.55	135.55
Pd_4Y_6/rGO	107.73	0.38	0.40	73.02	79.79	939.32	8.63	169
Pd_2Y_8/rGO	96.05	0.41	0.69	32.48	44.31	410.84	4.3	211
Pd/rGO	80.78	0.43	0.27	28.36	30.67	368.16	4.5	251
Pd/C	76.88	0.47	0.29	21.70	24.81	285.73	3.6	278

ECSA = Electrochemical surface area from PdO reduction
E_f = Forward oxidation potential
E_b = Backward oxidation potential
J_f = Forward current density
J_b = Backward current density
MSA = Mass specific activity
SA = Specific activity
R_{ct} = Resistance to charge transfer

Table S2. Calculated amount of each metal in all the synthesized electrocatalyst determined from

Catalyst	**Wt % of Pd**	**Wt % of Y**
Pd_6Y_4/rGO	11.69	6.75
Pd_4Y_6/rGO	6.97	11.54
Pd_2Y_8/rGO	3.53	15.24

AAS (Atomic absorption spectroscopy)

Table S3. Optimum analytical conditions maintained for analysis of selected trace metals in the synthesized electrocatalysts using atomic absorption spectrophotometer

Pd_6Y_4/rGO					
Metal	Wavelength (nm)	HCl current (mA)	Slit width (mm)	Fuel gas flow rate (L/min)	Detection ppm Limit (µg/L)
Pd	450	5.0	0.5	2.6	2.97
Y	256	5.0	0.5	2.6	1.94
Pd_4Y_6/rGO					
Pd	450	5.0	0.5	2.6	1.95
Y	256	5.0	0.5	2.6	2.95
Pd_2Y_8/rGO					
Pd	450	5.0	0.5	2.6	0.98
Y	256	5.0	0.5	2.6	3.96

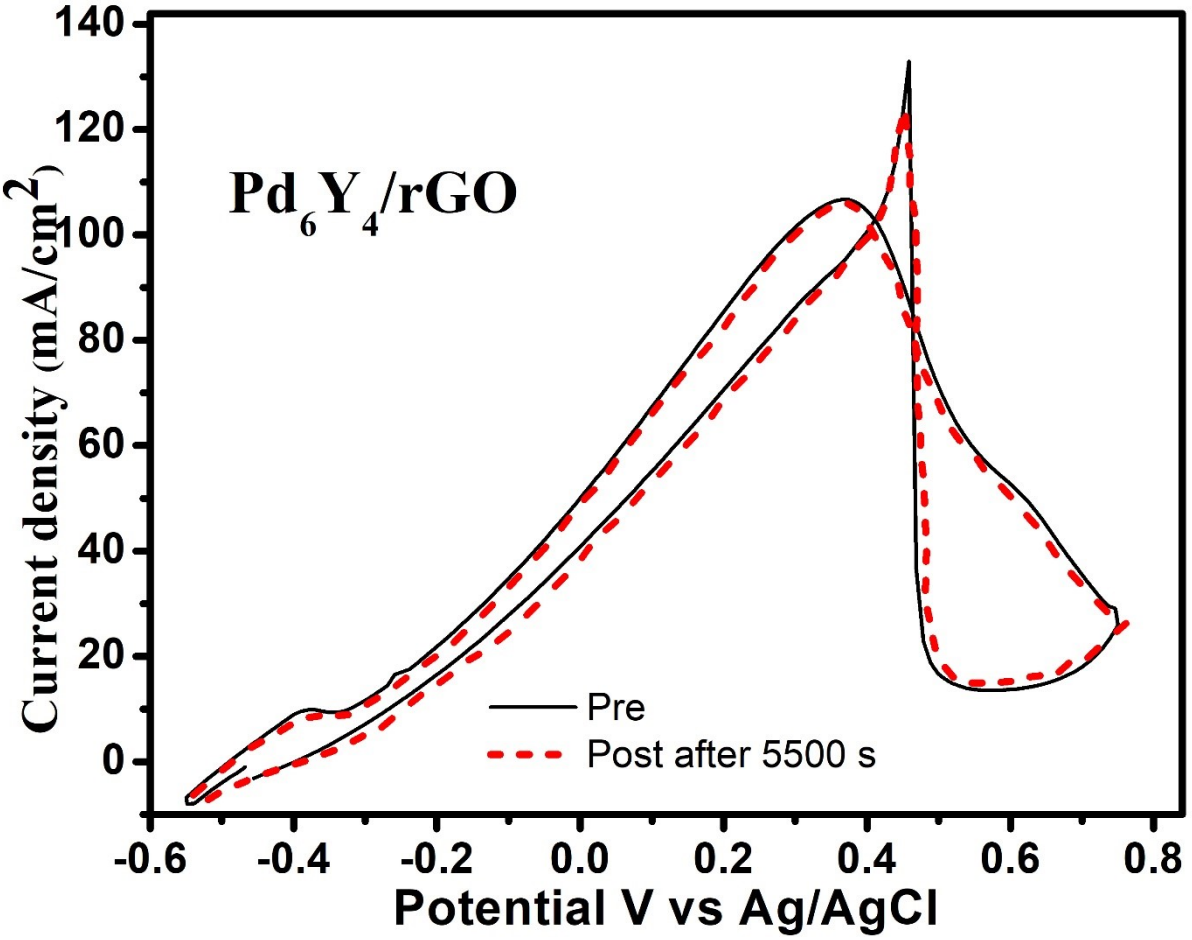

Figure S11: Pre and post CV of Pd_6Y_4/rGO

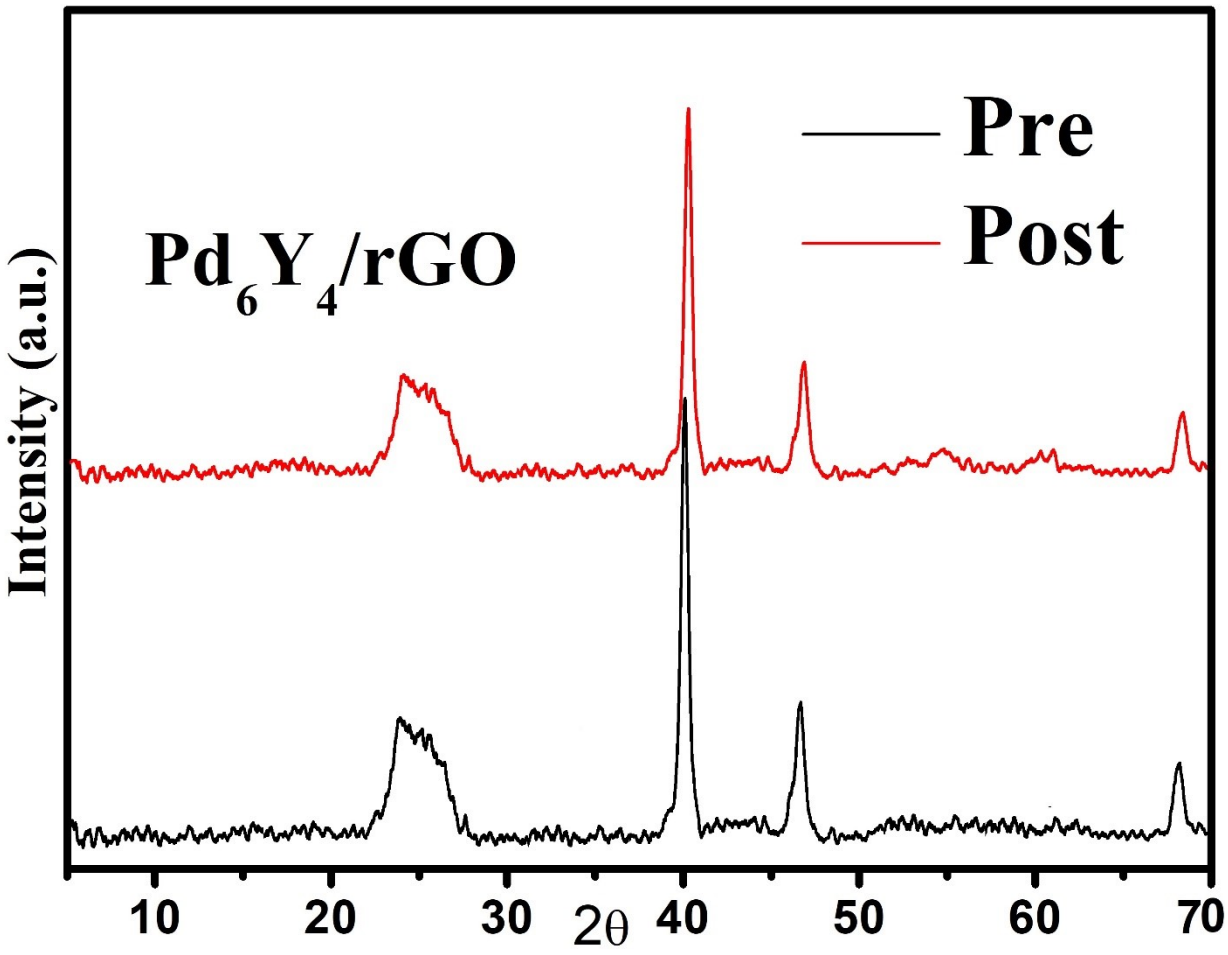

Figure S12: Post and pre PXRD pattern of Pd_6Y_4/rGO

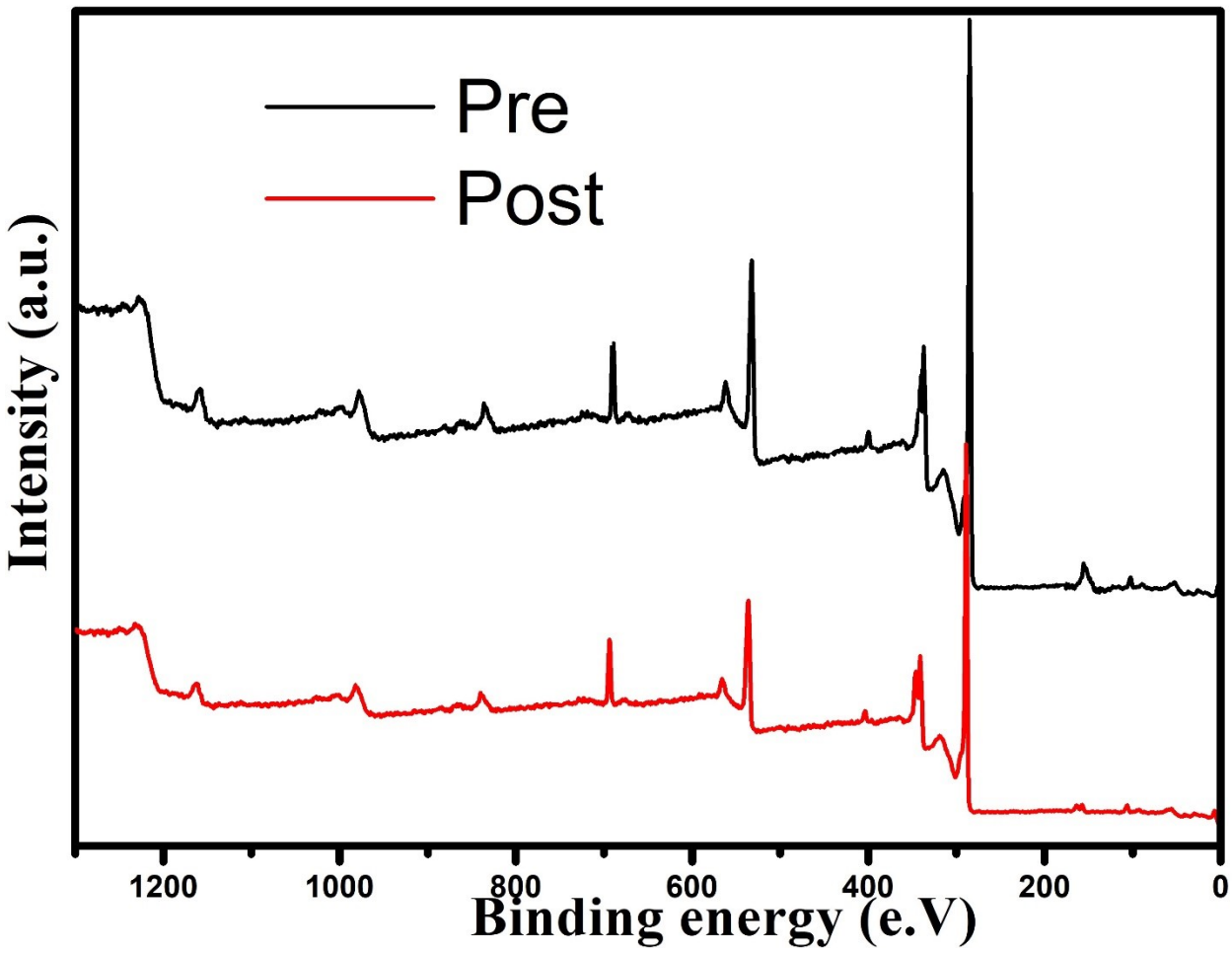

Figure S13: Pre and post XPS survey of Pd_6Y_4/rGO

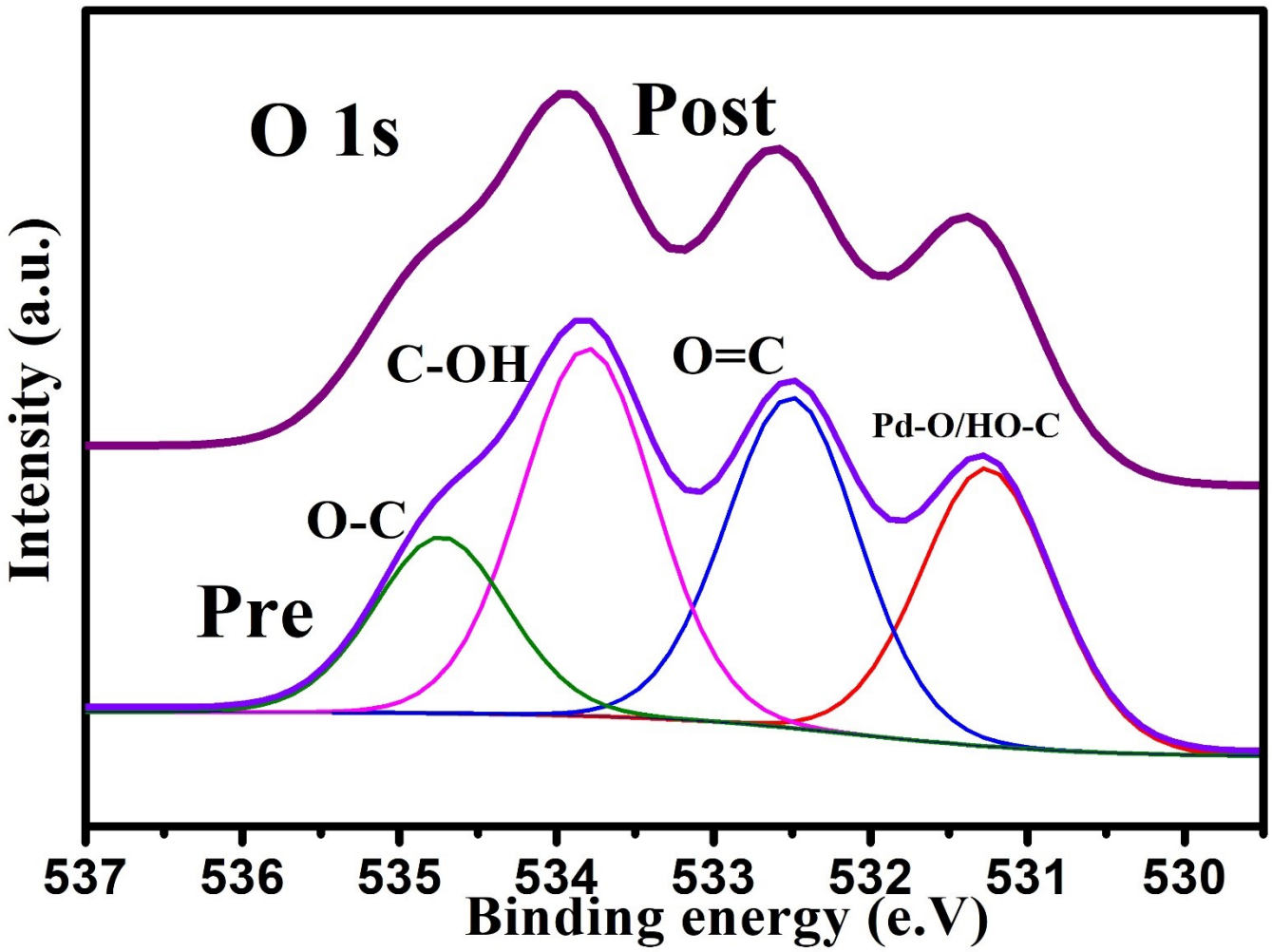

Figure S14: Pre and post XPS of O