Supporting Information

PdP/WO_3 Multi-functional Catalyst with High Activity and Stability for Direct Liquid Fuel Cells

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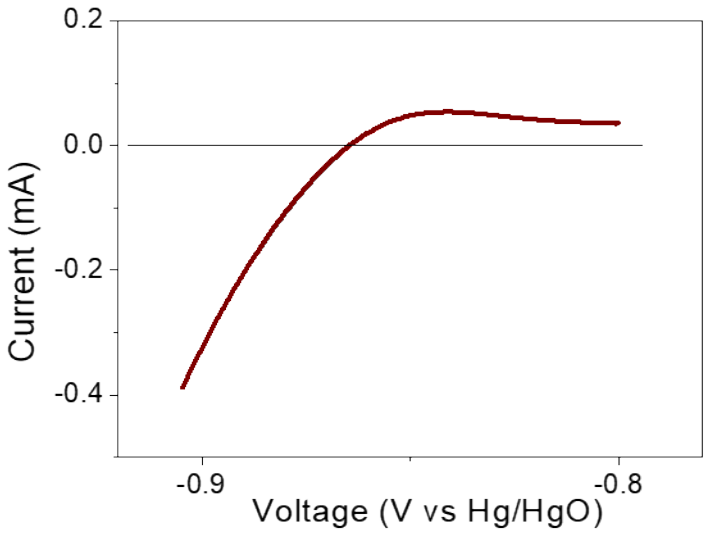

Figure S1 The calibration curve corresponding to the Hg/HgO reference electrode.

To get the values corresponding to RHE, CV in H_2 saturated 0.1 M KOH was performed at a scan rate of 1 mV sec^{-1} by employing Hg/HgO as the reference electrode, Pt as the counter electrode, and Pt disc as the working electrode. The potential at which the current crosses the zero line will be taken as the correction factor. The intersection point measured in this case is 0.878 V.

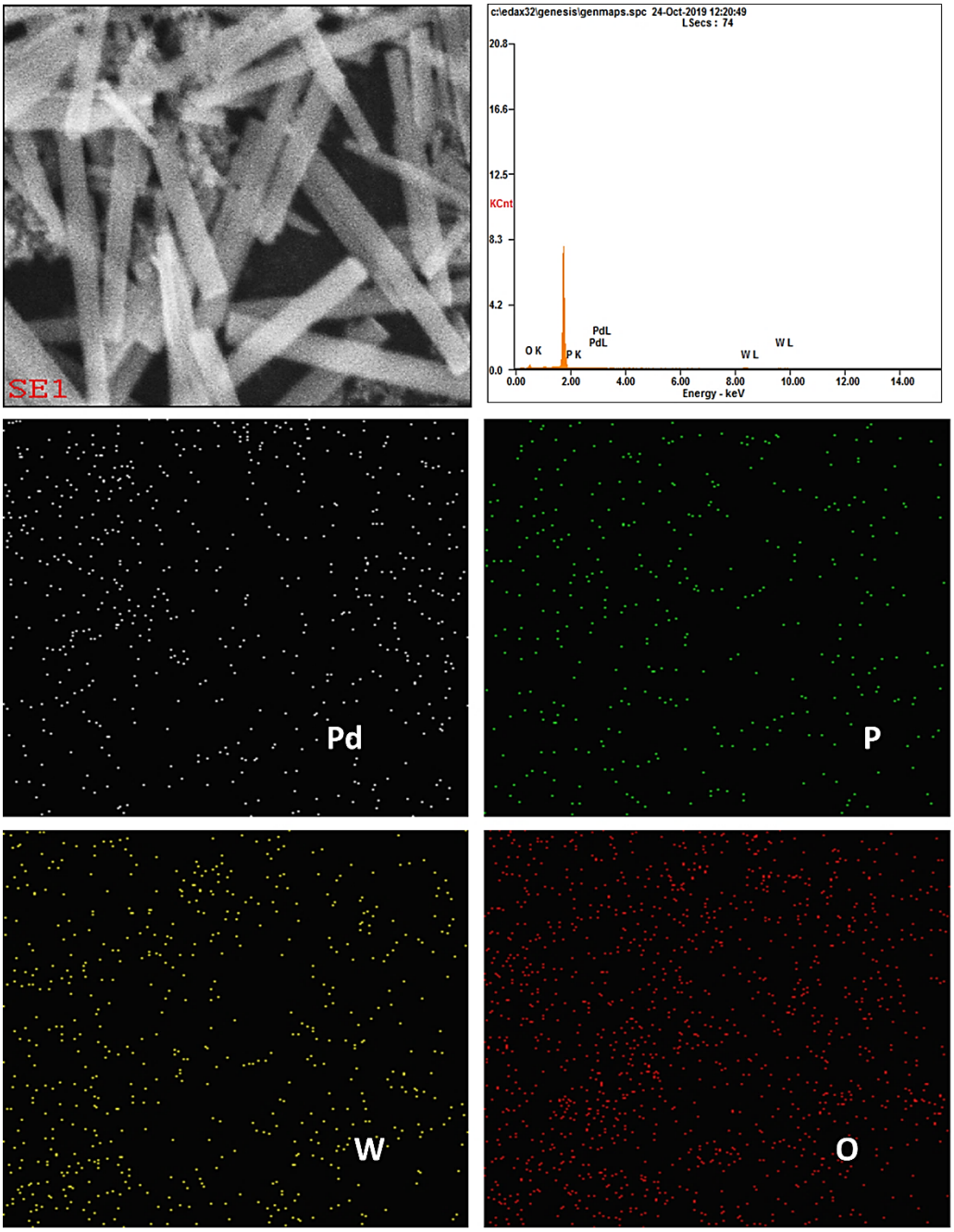

Figure S2. FESM images of PdP/WO_3 showing the elemental distribution of Palladium (Pd), Phosphorous (P), Tungsten (W) and Oxygen (O).

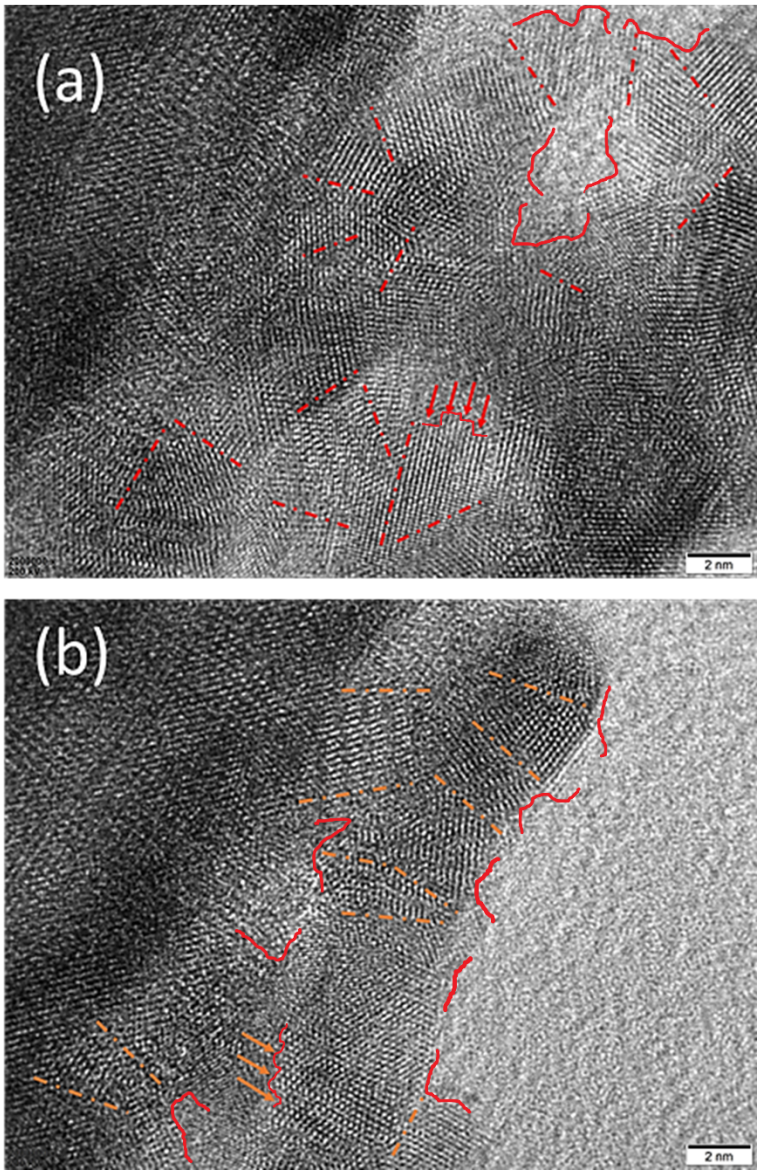

Figure S3. The HR-TEM images of PdP/WO_3, where the dashed lines show the defects generated, while the red lines and arrows shows the kink and the step edges, respectively.

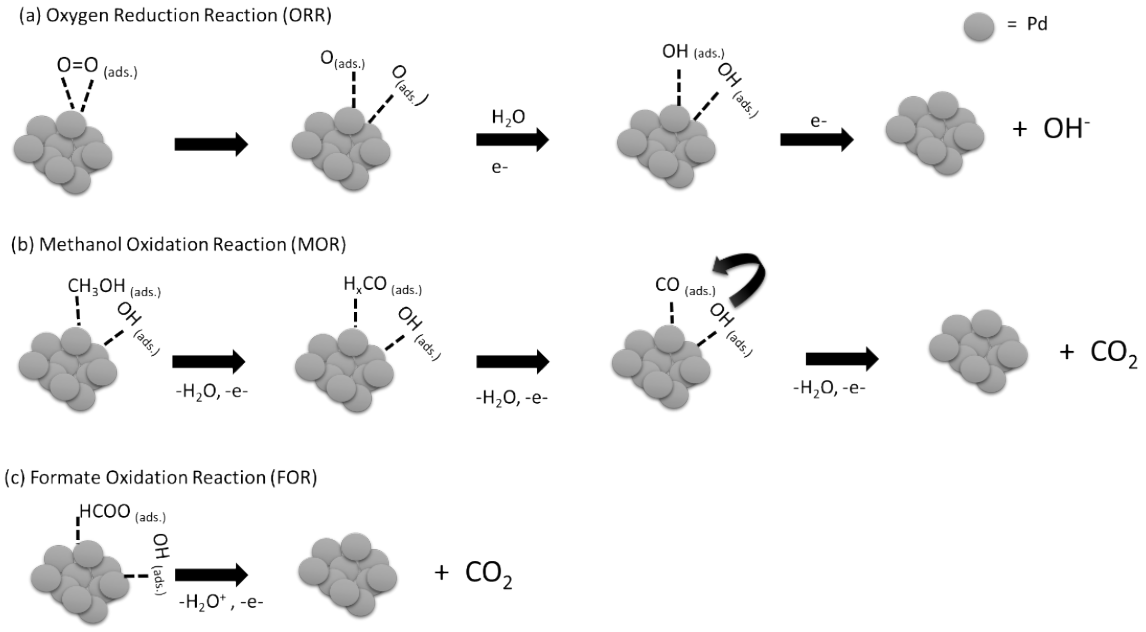

Figure S4. The proposed reaction mechanism: (a) oxygen reduction reaction, (b) methanol oxidation reaction, and (b) formate oxidation reaction.

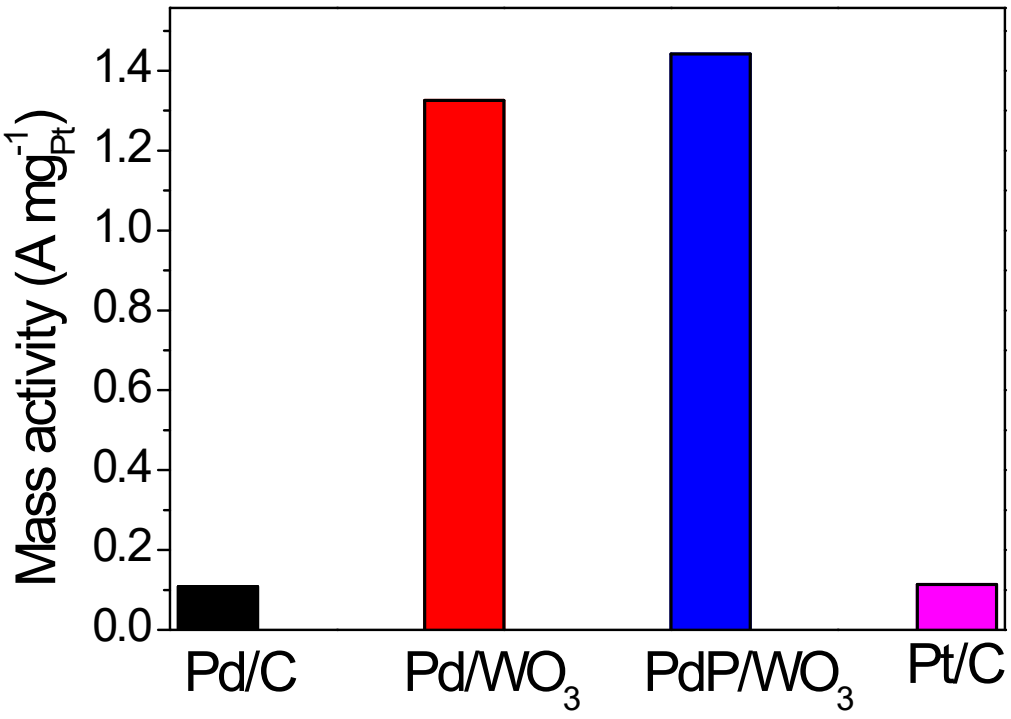

Figure S5. Mass activity comparison of the different catalysts at a potential of 0.90 V.

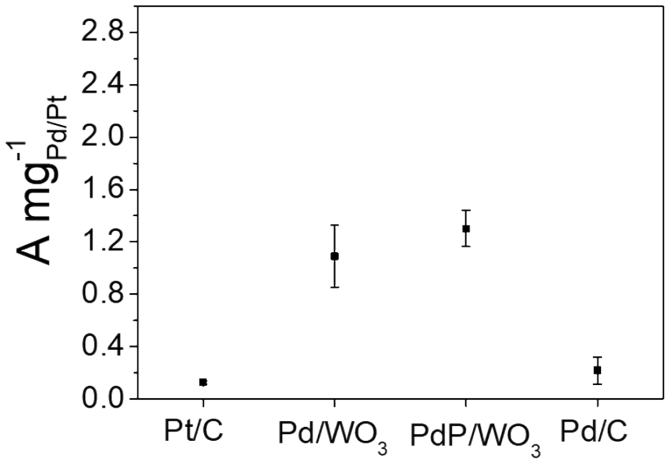

Figure S6. The figure showing the experimental error of the different catalysts for ORR calculated at a potnetial of 0.90 V.

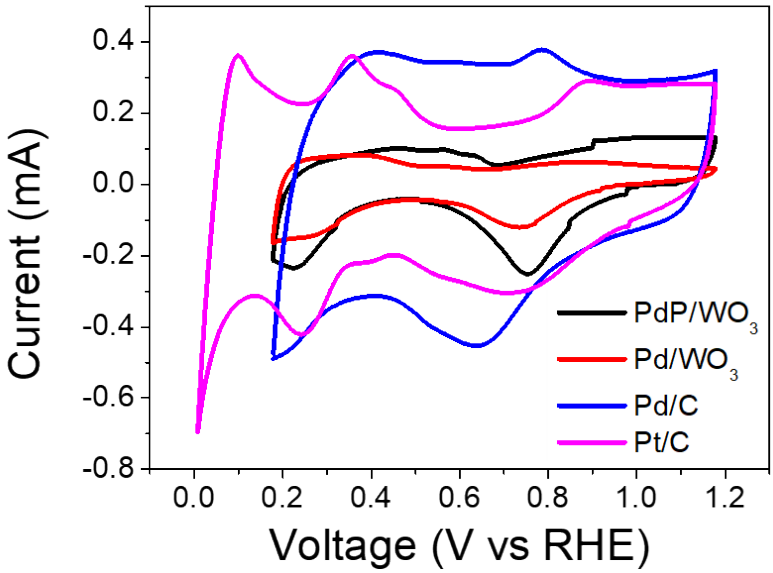

Figure S7. CVs recorded for the different catalysts used for evaluating ECSA; the plots were recorded in 0.1 M KOH under N_2 saturated environment at a scan rate of 50 mV sec^{-1}.

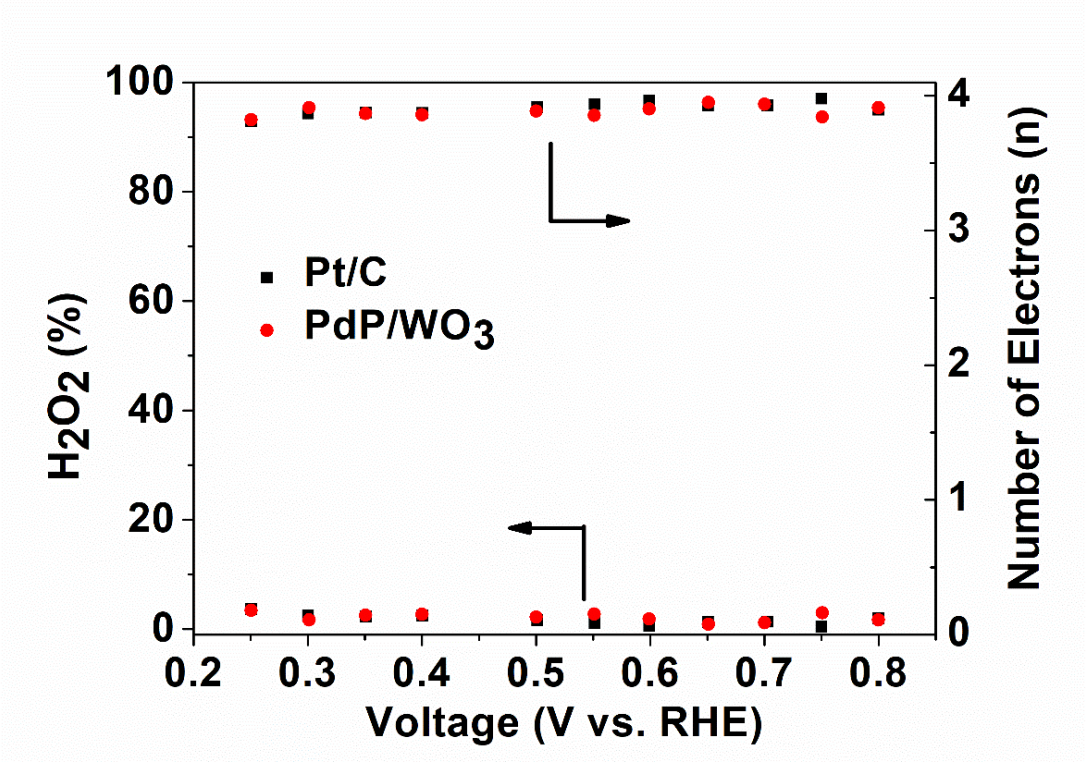

Figure S8. The percentage of H_2O_2 and the number of electron transference estimated for the oxygen reduction reaction by the rotating ring disc electrode method on the various catalysts.

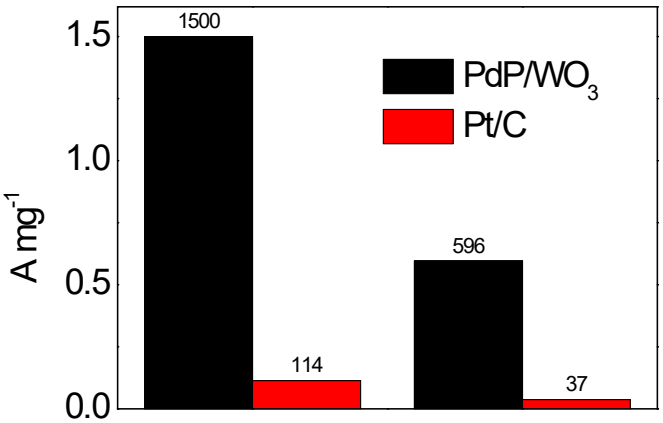

Figure S9. Mass activity comparison of the different catalysts at a potential of 0.90 V before and after the 3000 Start-Stop Cycles.

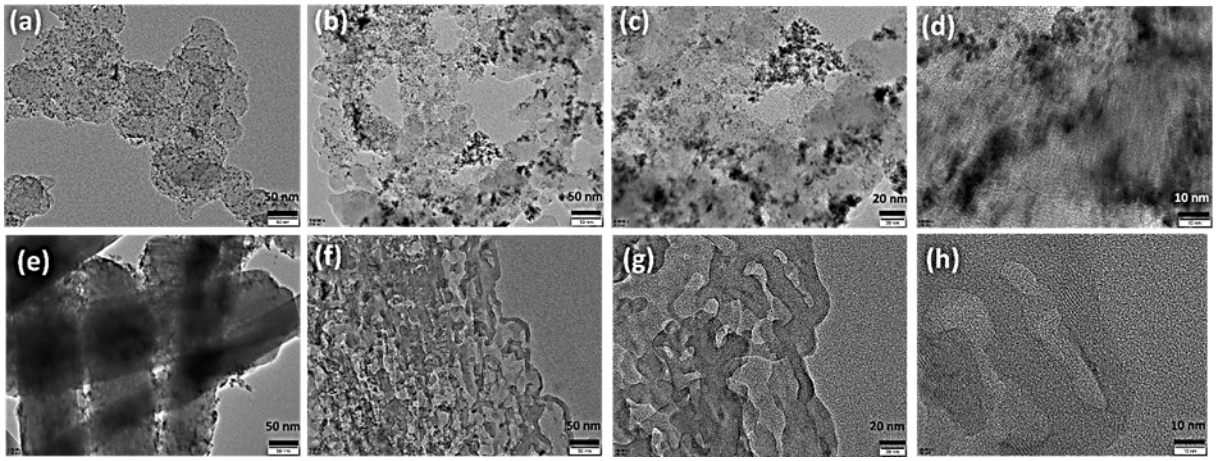

Figure S10. TEM images of Pt/C and PdP/WO_3 recorded before and after the durability test: (a) and (c) are the TEM images of Pt/C and PdP/WO_3 before the durability test, (b-d) are the TEM images after the durability test, and (f-h) are the TEM images of the PdP/WO_3 after the durability test.

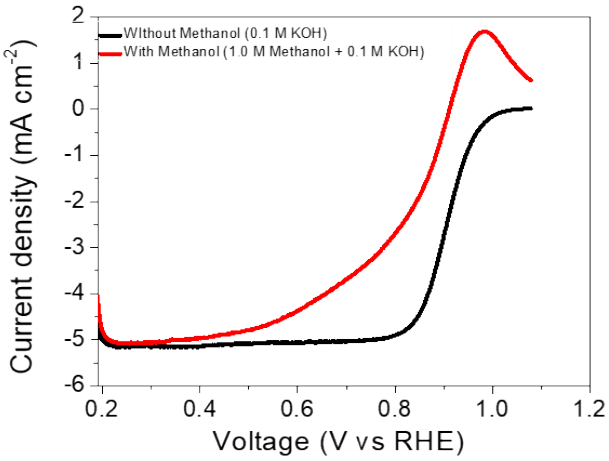

Figure S11. The LSV plots recorded in O_2 saturated 0.1 M KOH with and without methanol at 1600 rpm at a scan rate of 1600 rpm.

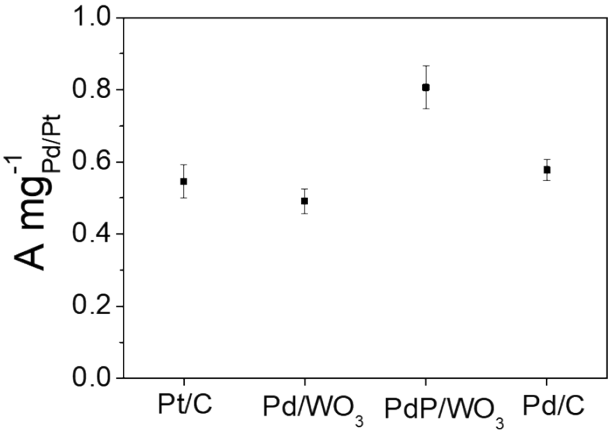

Figure S12. The graph showing the experimental error of the different catalysts for MOR as calculated at the peak potential.

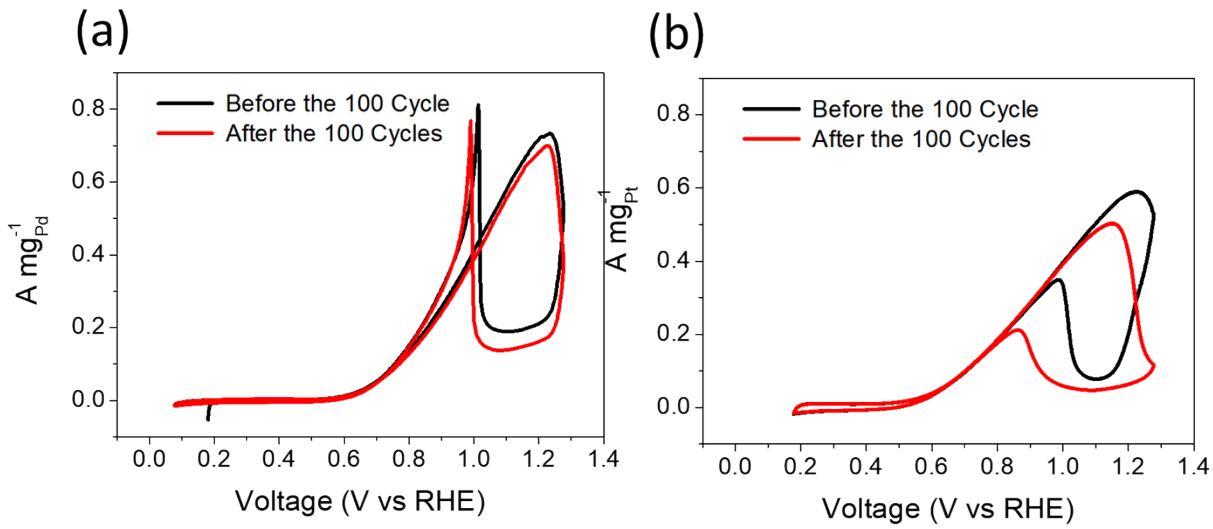

Figure S13. (a) Comparative CV profiles for PdP/WO_3 recorded before and after the 100 cycles at a scan rate of 50 mV sec^{-1} and (b) comparative CV profiles for Pt/C before and after the 100 start-stop cycles recorded at a scan rate of 50 mV sec^{-1}

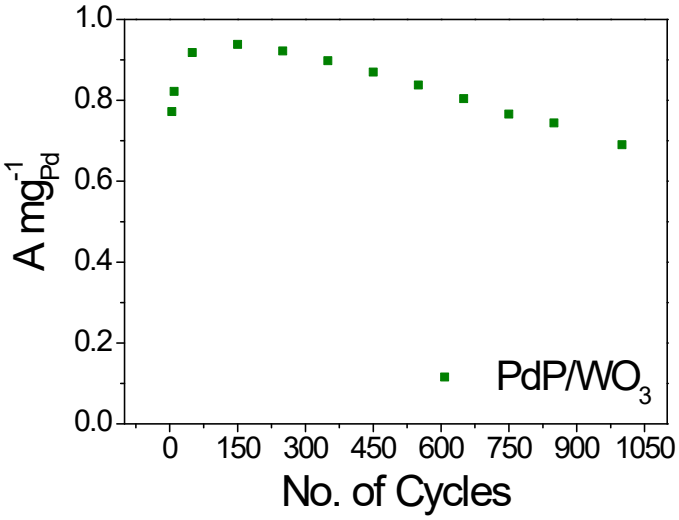

Figure S14 The mass activity *vs* the number of cycles measured at the peak potential in 0.1 M KOH and 1.0 M MeOH in N_2 saturated environment at a scan rate of 100 mV sec^{-1}.

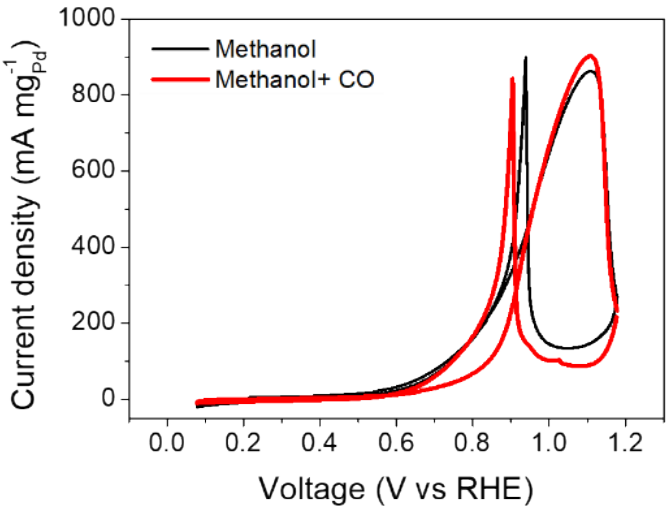

Figure S15. The CV profiles of PdP/WO_3 in 0.1 M KOH and 1.0 M methanol recorded at a scan rate of 50 mV sec^{-1}in the presence and absence of CO.

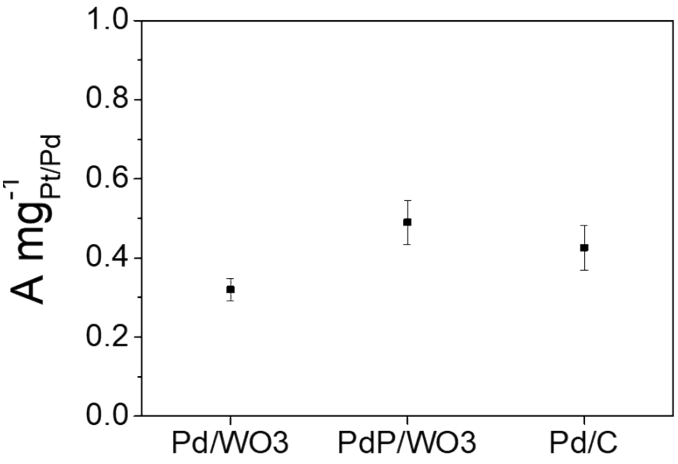

Figure S16. The graph representing the experimental error of the different catalysts for FOR as calculated at the potential of 0.60 V.

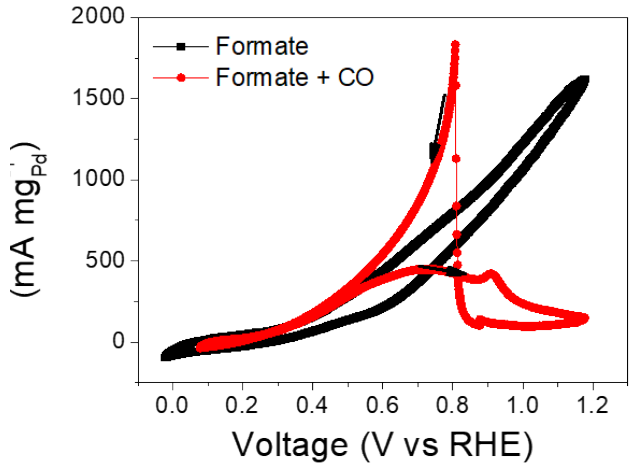

Figure S17. The CV profiles of PdP/WO_3 recorded in 0.1 M KOH and 1.0 M methanol at a scan rate of 50 mV sec^{-1} in the presence and absence of CO.

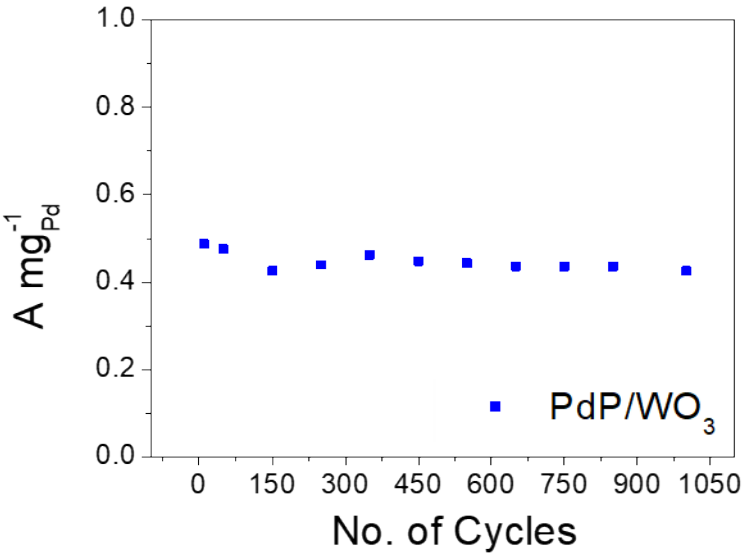

Figure S18. The plot representing the mass activity *vs* the number of cycles at a potential of 0.60 V carried out in 0.3 M KOH and 0.1 M HCOOH in N_2 saturated environment at a scan rate of 100 mV sec^{-1}.