

Figure S1 XPS full spectra of (a)  $C_{0.5}V_{0.24}CP$  and (b)  $C_{0.5}V_{2.24}CP$ .

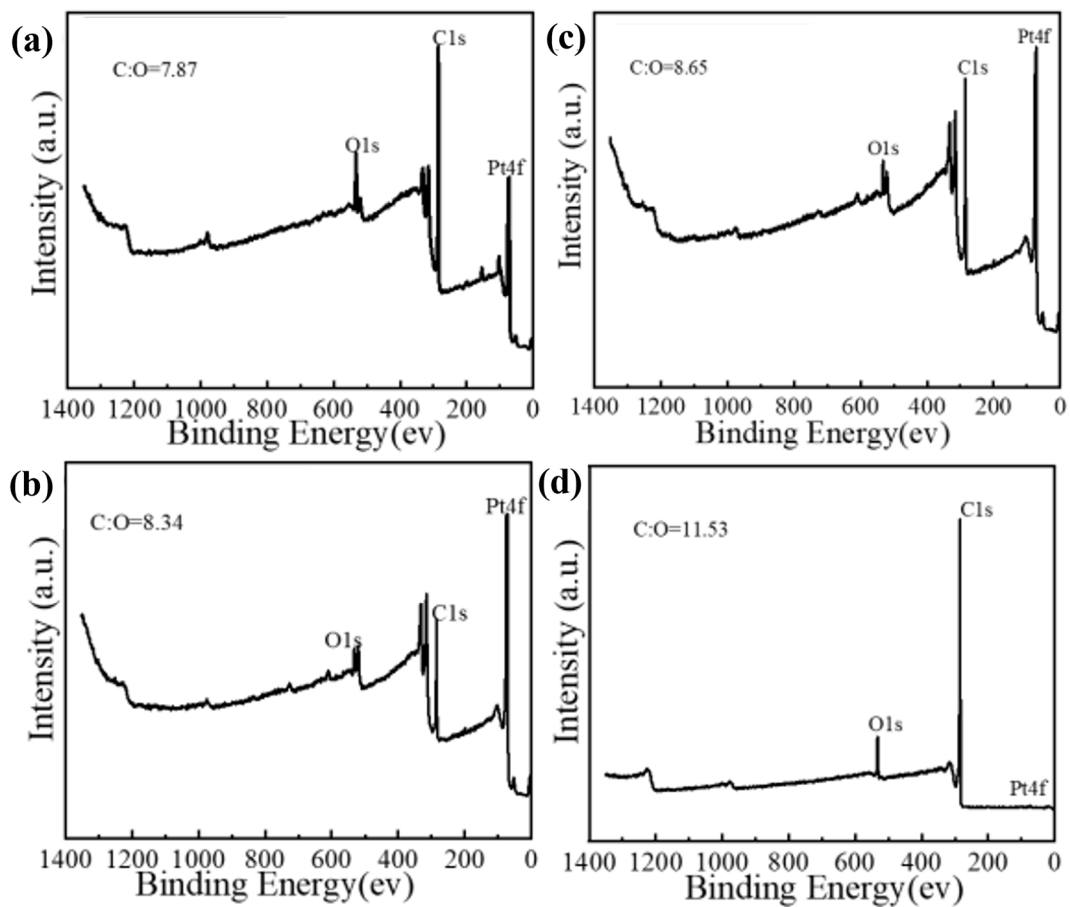


Figure S2 XPS full spectra of (a) Pt/C<sub>0.5</sub>V<sub>0.24</sub>CP、(b) Pt/C<sub>0.5</sub>V<sub>1.84</sub>CP、(c) Pt/C<sub>0.5</sub>V<sub>2.04</sub>CP and (d) Pt/C<sub>0.5</sub>V<sub>2.24</sub>CP catalysts.

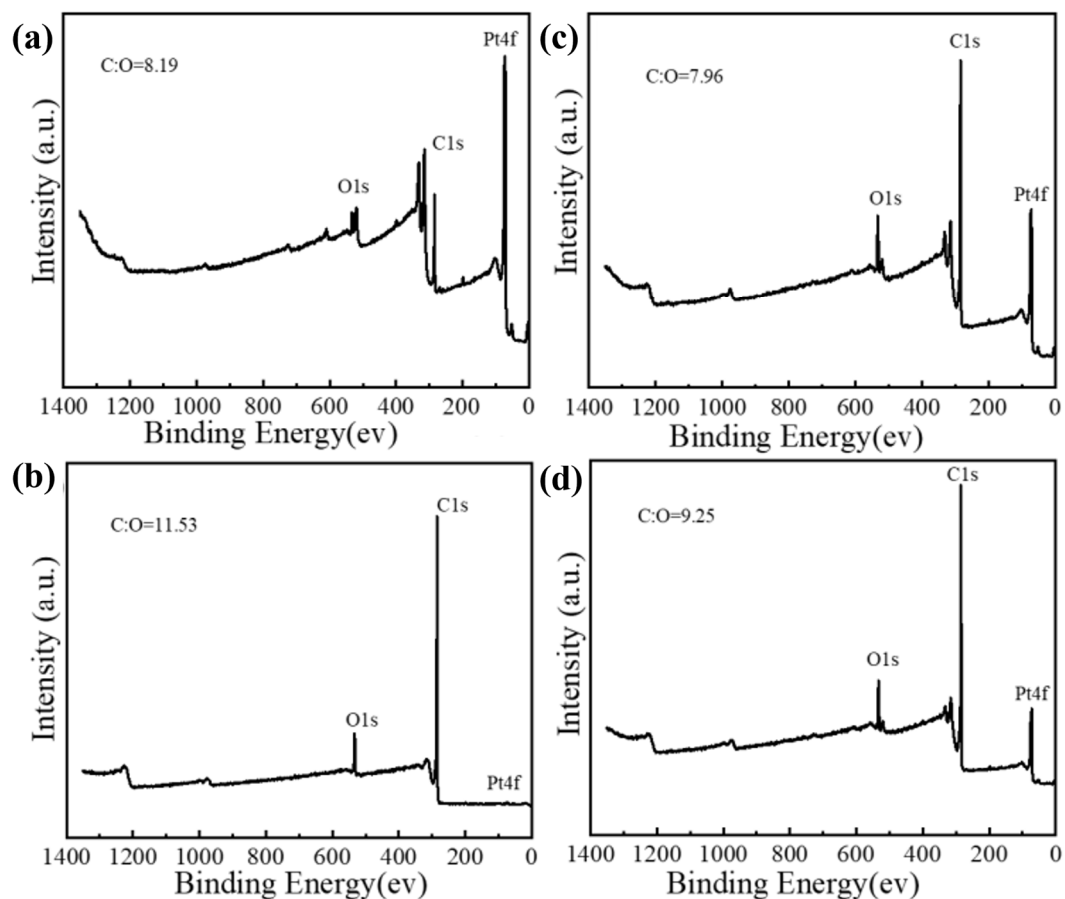


Figure S3 XPS full spectra of (a) Pt/C<sub>0.25</sub>V<sub>2.24</sub>CP、(b) Pt/C<sub>0.5</sub>V<sub>2.24</sub>CP、(c) Pt/C<sub>1.0</sub>V<sub>2.24</sub>CP and (d) Pt/C<sub>2.0</sub>V<sub>2.24</sub>CP catalysts.

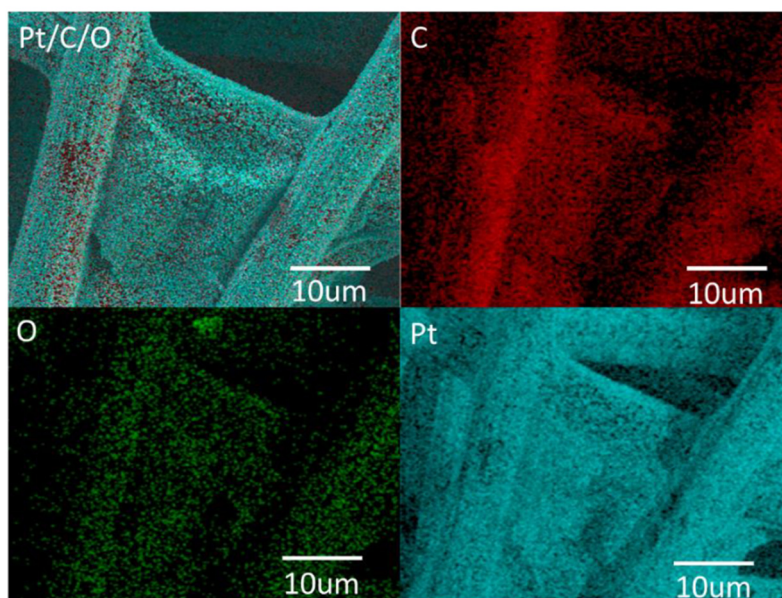


Figure S4 Mapping diagram of Pt/C<sub>2.0</sub>V<sub>2.24</sub>CP catalyst electrode.

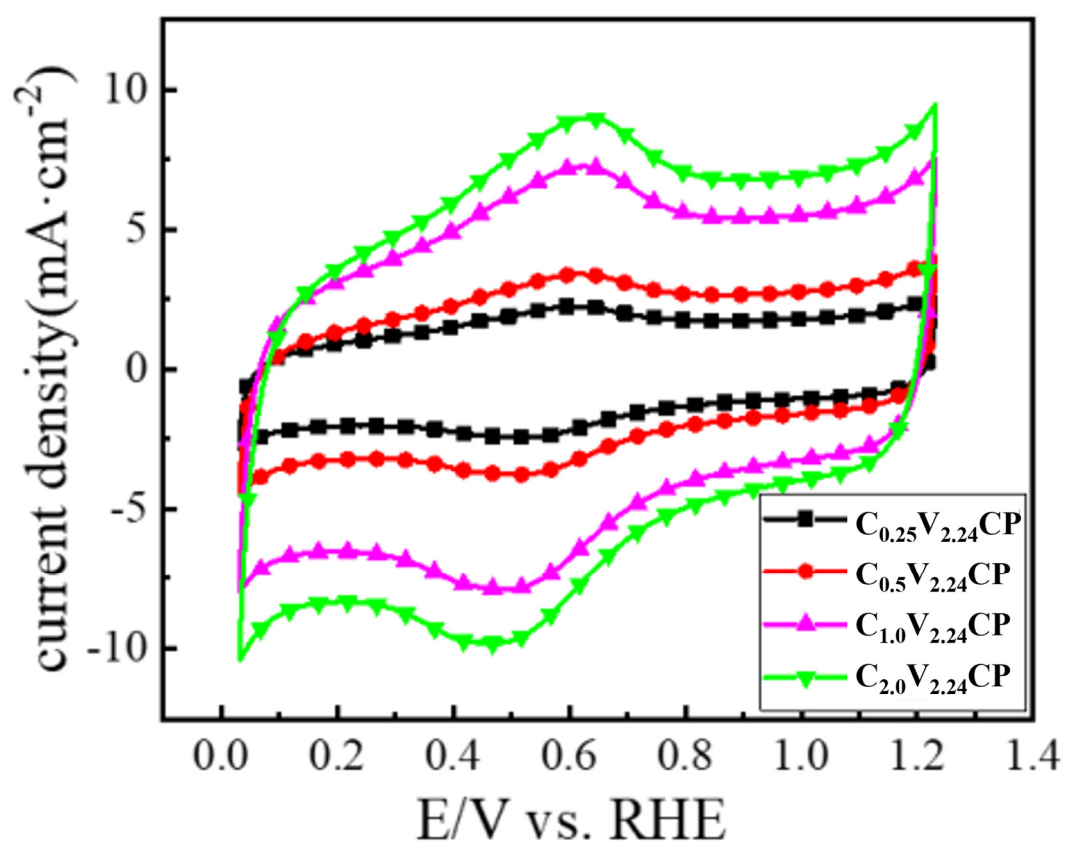


Figure S5 CV diagram of  $C_{0.25}V_{2.24}CP$ 、 $C_{0.5}V_{2.24}CP$ 、 $C_{1.0}V_{2.24}CP$  and  $C_{2.0}V_{2.24}CP$  in 0.5 M  $H_2SO_4$ , 100  $mV \cdot s^{-1}$  sweep rate in Ar environment.

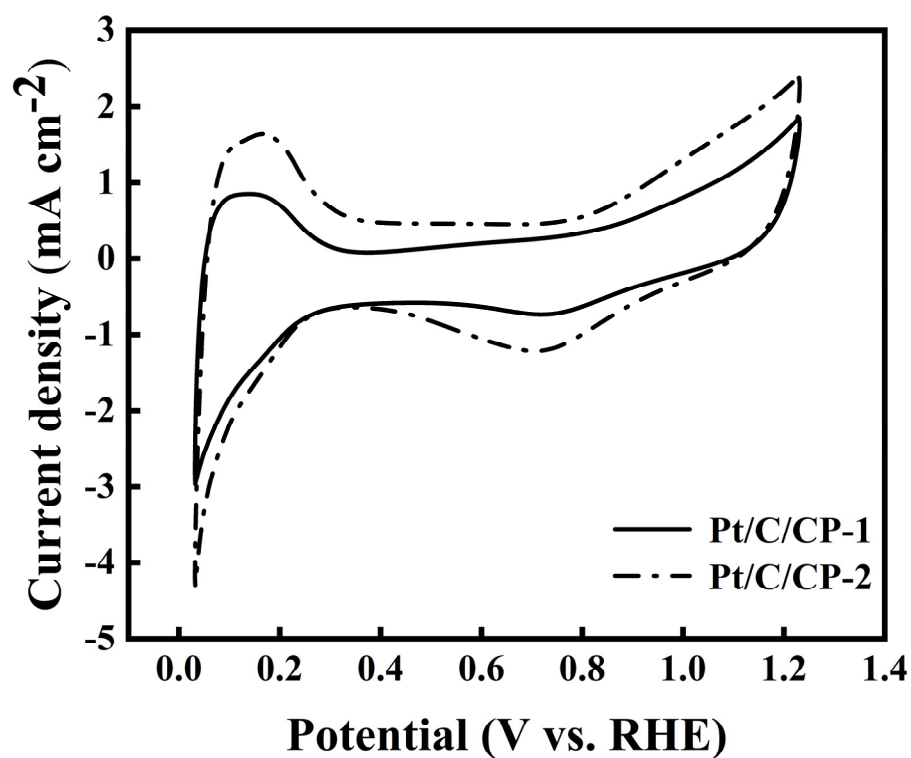


Figure S6 CV diagram of commercial catalysts in 0.5 M  $\text{H}_2\text{SO}_4$ ,  $100 \text{ mV} \cdot \text{s}^{-1}$  sweep rate in Ar environment.

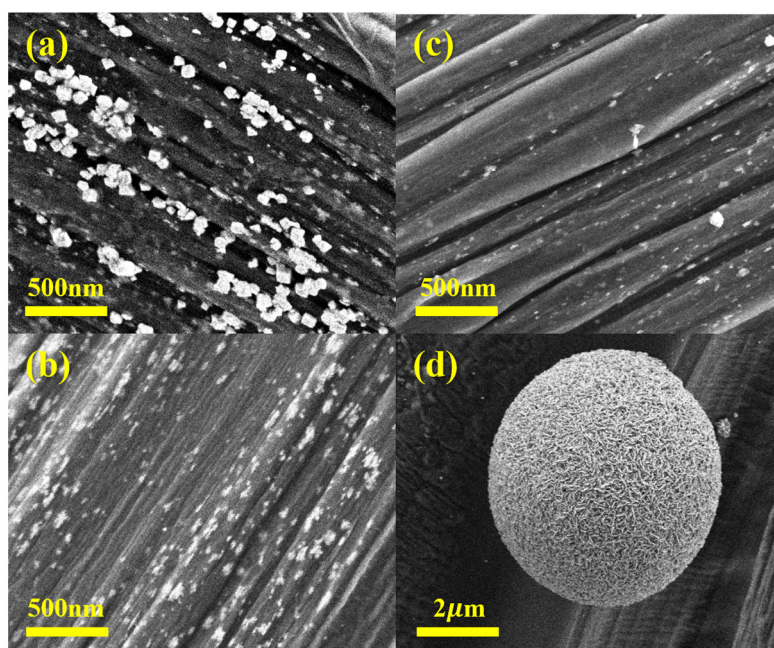


Figure S7 SEM images of the (a)  $\text{Pt/C}_{0.5}\text{V}_{0.24}\text{CP}$ , (b)  $\text{Pt/C}_{0.5}\text{V}_{1.84}\text{CP}$ , (c, d) different areas of  $\text{Pt/C}_{0.5}\text{V}_{2.04}\text{CP}$  after ADT.

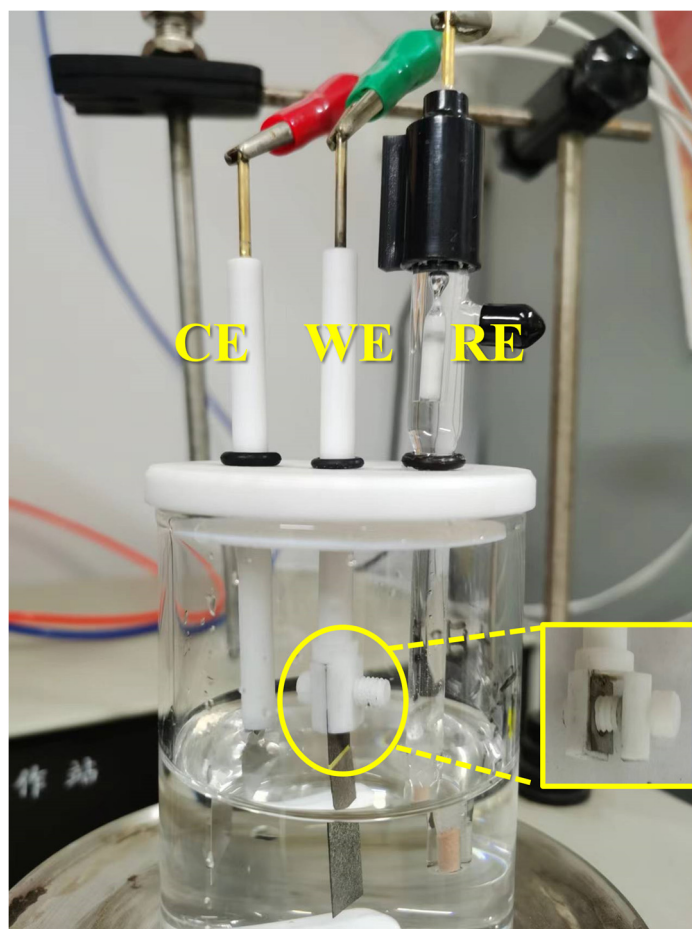


Figure S8 Set-up of the three-electrode electrochemical cell with the Pt counter electrode (CE), SCE reference electrode (RE) and CP working electrode (WE).