

## Supplementary Information

### Electrochemical dehydrogenation of cyclohexane to cyclohexene in a proton-conducting solid oxide electrolyzer

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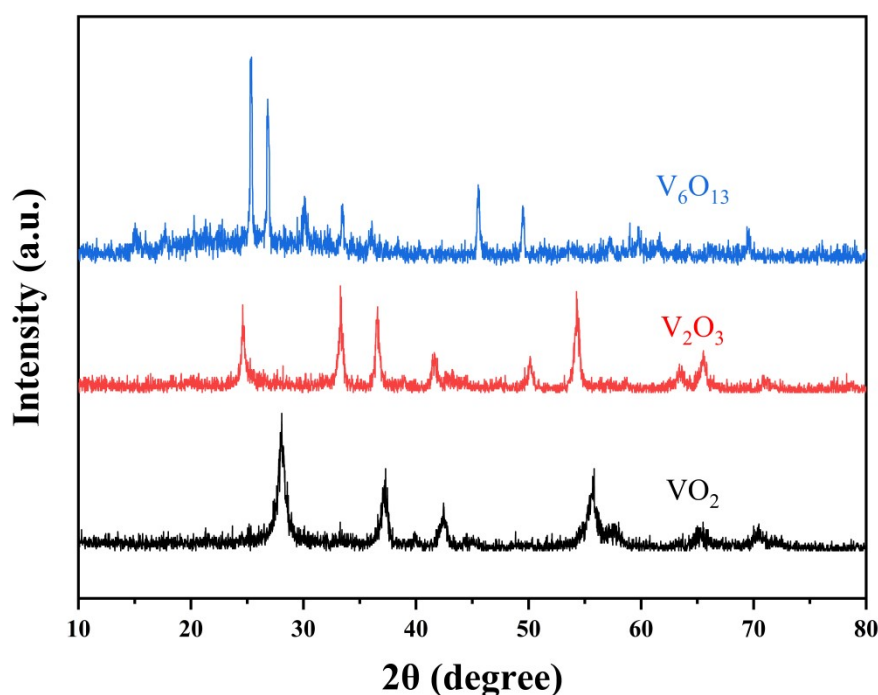


Fig.S1 XRD images of  $V_6O_{13}$ ,  $VO_2$  and  $V_2O_3$ .

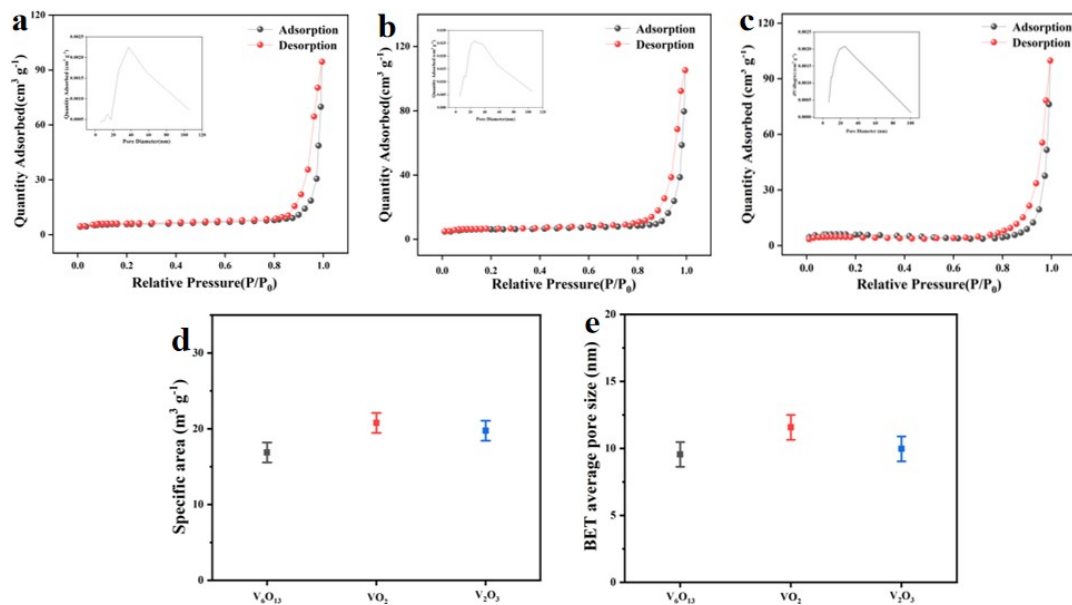


Fig.S2  $N_2$  adsorption-desorption isotherms and the corresponding pore diameter distribution of porous single crystal micron particles, (a)  $V_6O_{13}$ , (b)  $VO_2$  and (c)  $V_2O_3$ ; The surface specific area (d) and average pore size (e) of the porous single crystal micro particles.

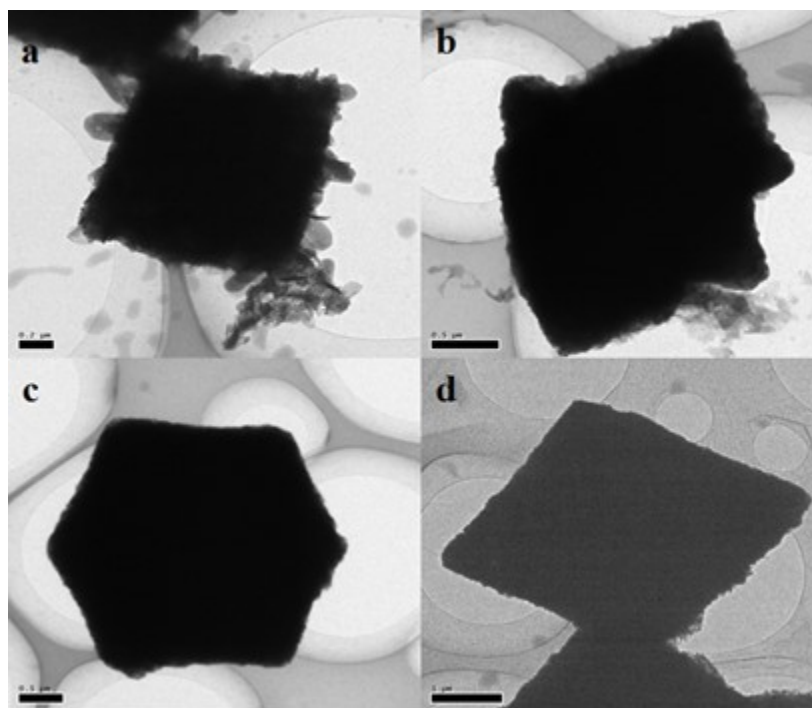


Fig.S3 TEM images of (a)  $\text{NH}_4\text{V}_4\text{O}_{10}$ , (b)  $\text{V}_6\text{O}_{13}$ , (c)  $\text{VO}_2$ , (d)  $\text{V}_2\text{O}_3$  porous single crystal microparticles.

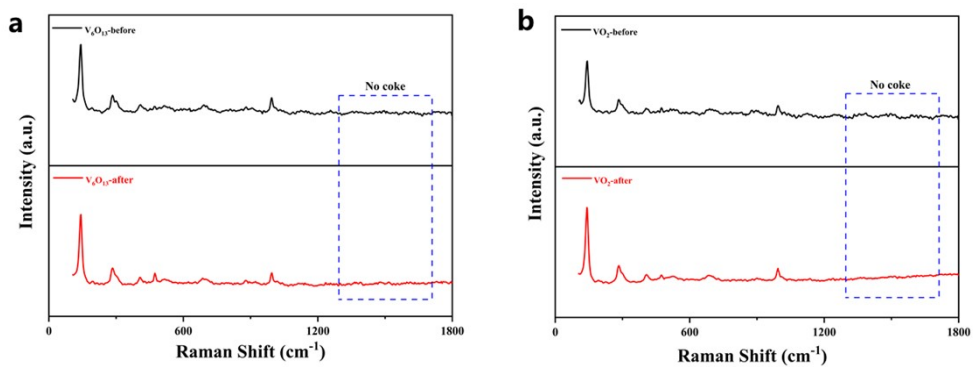


Fig.S4 Raman spectra of the PSC (a)  $\text{V}_6\text{O}_{13}$  and (b)  $\text{VO}_2$  powder before (black line) and after (red line) the dehydrogenation of ethane reaction.

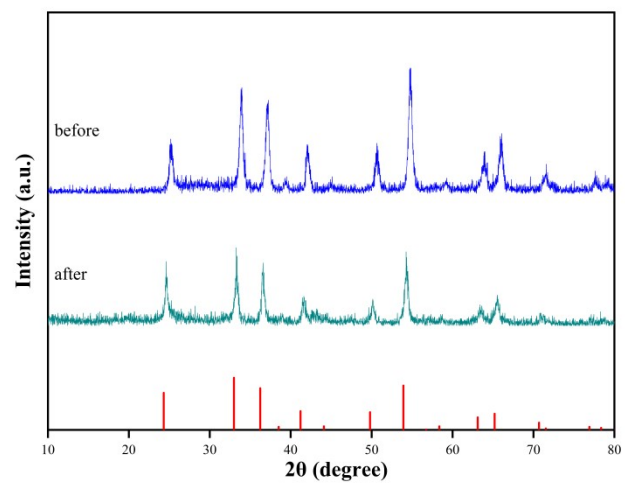


Fig.S5 Comparison of XRD patterns of  $V_2O_5$  before and after stability testing.

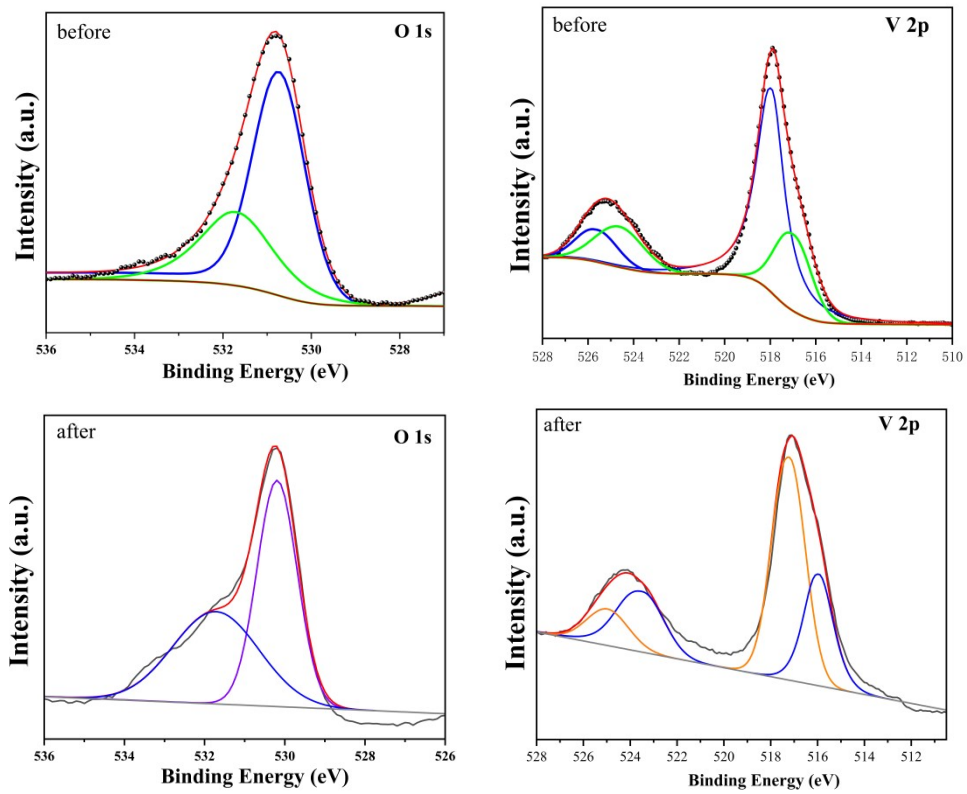


Fig.S6 Comparison of XPS patterns of  $V_2O_3$  before and after stability testing.

Fig.S7 Comparison of SEM patterns of electrode cross-section before and after stability testing.

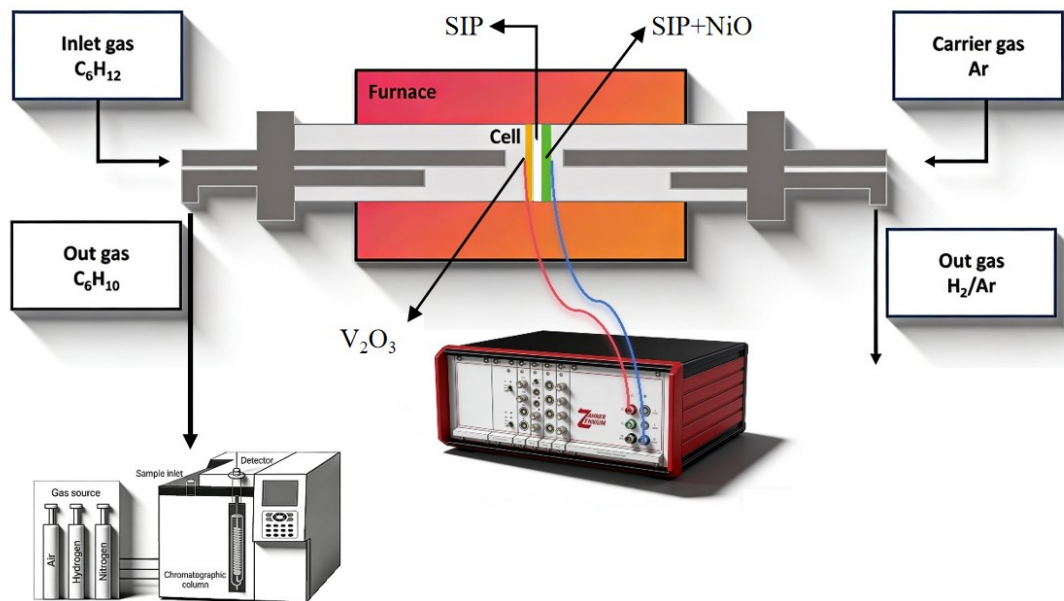


Fig.S8 Schematic of the performance measurement setup.