

Hollow palladium nanospheres with porous shell supported on graphene as enhanced electrocatalyst for formic acid oxidation

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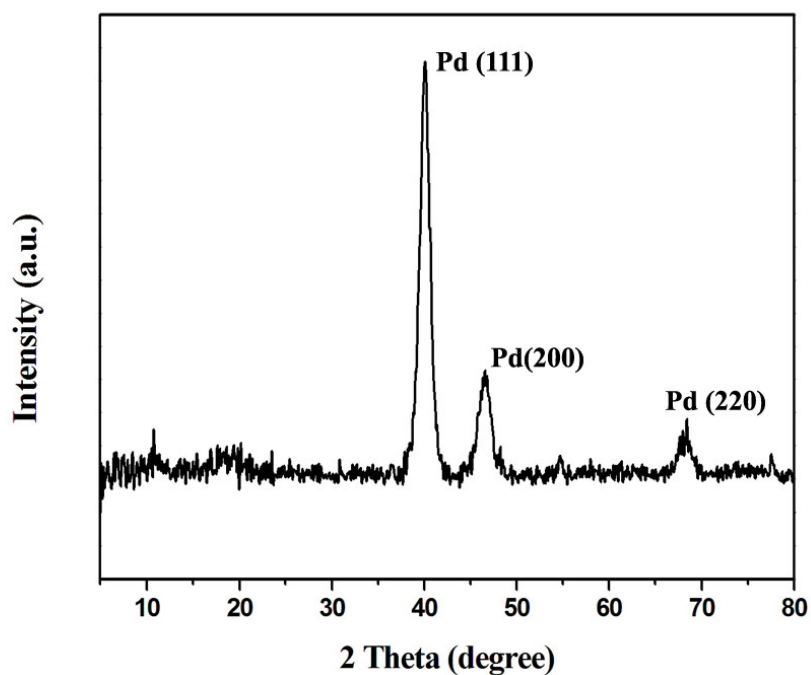


Fig. S1 XRD pattern of the synthetic Pd NS-HP sample.

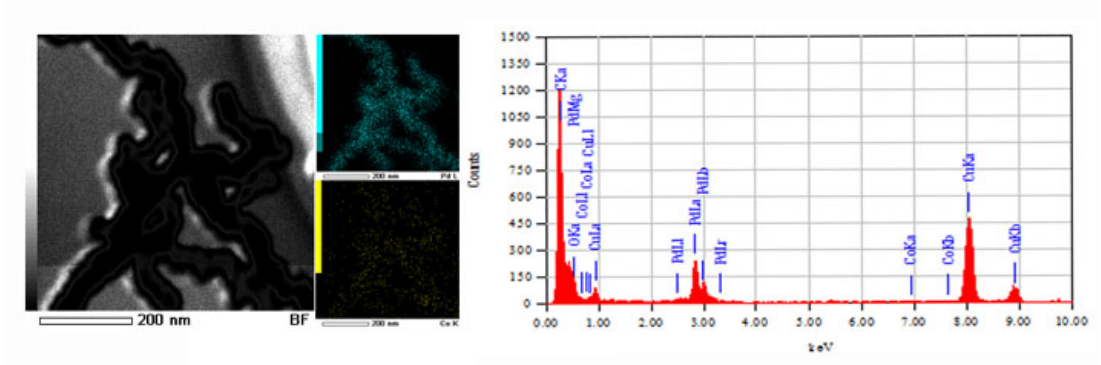


Fig. S2 Element analysis mapping of Pd (blue), Co (yellow) and energy-dispersive X-ray analysis (EDX) of Pd NS-HP sample.

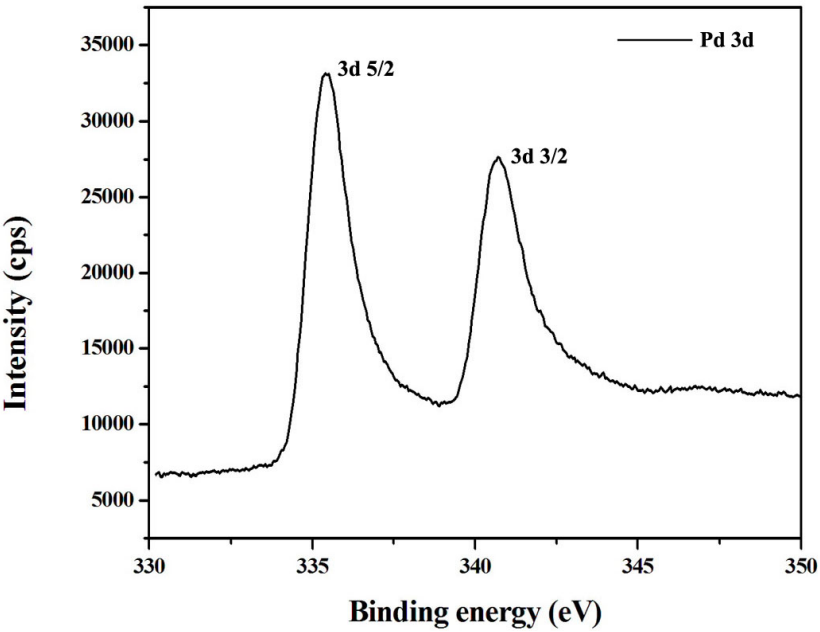


Fig. S3 Pd 3d XPS spectra of the synthetic Pd NS-HP.

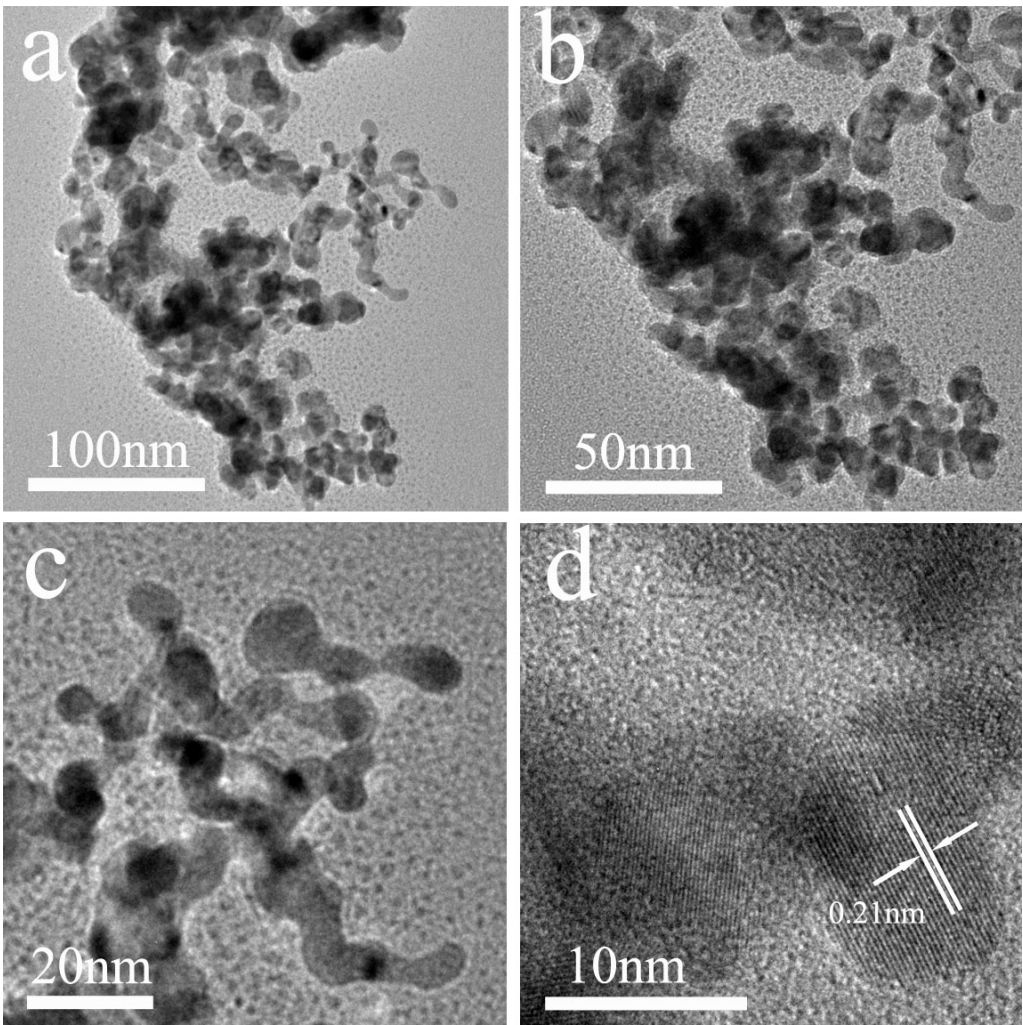


Fig. S4 TEM images of the sample synthesized without PVP surfactant.

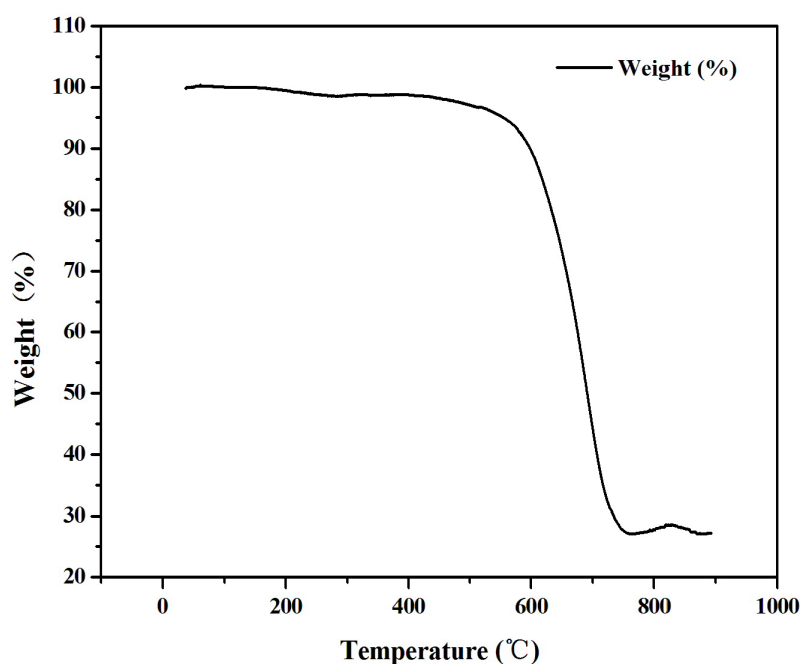


Fig. S5 Thermogravimetric analysis curve for the Pd NS-HP/GN sample tested in air.

Fig. S5 shows the thermogravimetric (TG) analysis curves of the corresponding composition in air ambient at a heating rate of $10\text{ }^{\circ}\text{C min}^{-1}$. It can be seen that the weight of Pd NS-HP/GN decreased about 5 wt.% at 550 $^{\circ}\text{C}$. It decreases about 67 wt.% at 750 $^{\circ}\text{C}$, which should be ascribed to the combination of carbon and oxygen produce carbon dioxide and carbon monoxide. In the process of heating, the Pd metal in catalysts were easily oxidized to Pd oxide, then the Pd oxide would be decomposed at around 825 $^{\circ}\text{C}$. Finally, the residual product is pure Pd metal of 28 wt.%.

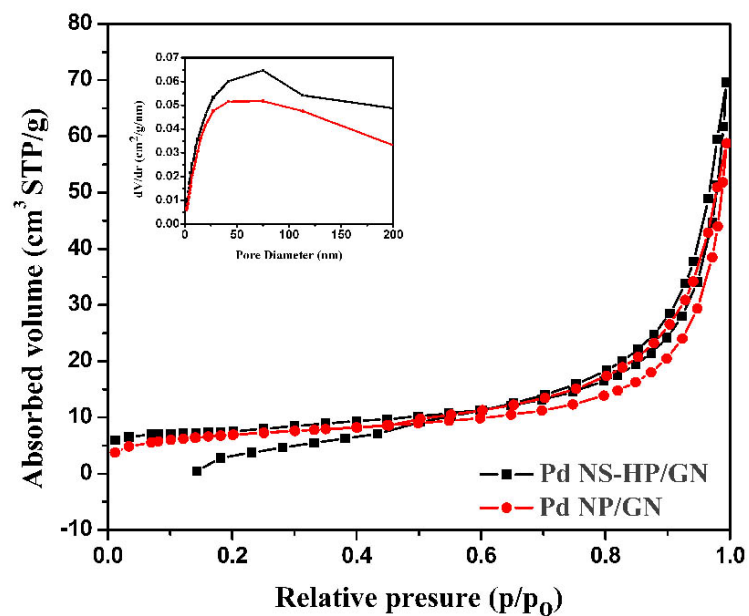


Fig. S6. Nitrogen adsorption-desorption isotherms and corresponding pore size distribution curves (inset) of Pd NS-HP/GN and Pd NP/GN catalysts.