

Supplementary data

Dry plasma reduction to prepare high performance Pd/C catalyst at atmospheric pressure for CO oxidation

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In order to illustrate the influence of supports on the properties of the supported Pd catalysts, XRD, XPS, TPR and TEM of the catalysts were characterized.

The XRD patterns of Pd/C-PC and Pd/TiO₂-PC were observed and shown in Fig. S1. The Pd peaks at 40.1° and 46.6° were attributed to the (111) and (200) planes of face-centered cubic structure of Pd (JCPDS card, File No. 46-1043), respectively. The main Pd (111) peak in Pd/C-PC and Pd/TiO₂-PC suggested that metallic Pd nanoparticles were formed.

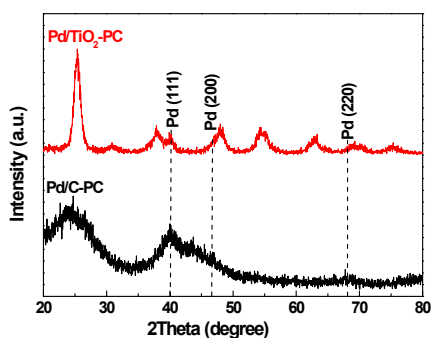


Fig. S1. XRD patterns of Pd/C-PC and Pd/TiO₂-PC.

The XPS spectra of Pd 3d in Pd/C-PC and Pd/TiO₂-PC were collected and shown in Fig. S2. It can be seen that Pd ions in Pd/TiO₂-PC had been completely reduced into metallic state, while the Pd ions were partially reduced in Pd/C-PC as a result of the oxygen-containing functional groups (Fig. 2). The shift of the binding energy of Pd3d in the two samples may be ascribed to the metal-support interaction.

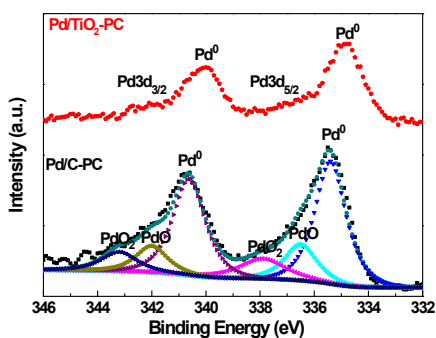


Fig. S2. XPS spectra of Pd 3d in Pd/C-PC and Pd/TiO₂-PC.

TPR profiles of Pd/C-PC and Pd/TiO₂-PC were illustrated in Fig. S3. The negative peaks observed around 70 °C in Pd/TiO₂-PC corresponded to desorption from surface metallic Pd of the H₂ adsorbed at room temperature at the beginning of the analysis. The relative intensities of this peak correlated with the size of Pd nanoparticles in each sample, and the disappearance of such a peak in Pd/C-PC revealed that the Pd species existed as very small nanoparticles. From Fig. S3, we can also see that the positive peaks observed at around 150 °C and 600 °C in Pd/C-PC, which were corresponded to H₂ consumption by PdO_x reduction and the reduction of the oxygen-containing functional groups, respectively. However, no obvious peak was observed in Pd/TiO₂-PC as a result of the fact that the Pd was exclusively metallic. The TPR data were consistent with the results of the XRD and XPS spectra.

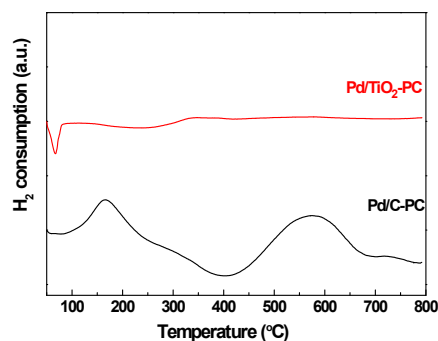


Fig. S3. TPR profiles of Pd/C-PC and Pd/TiO₂-PC.

The histograms of size distribution of the Pd nanoparticles for Pd/C-PC and Pd/TiO₂-PC were shown in Fig. S4. The Pd nanoparticles were 1.92±0.75 nm and 6.95±1.93 nm in diameter for Pd/C-PC and Pd/TiO₂-PC, respectively. Smaller and high dispersion of Pd nanoparticles were obtained for Pd/C-PC than in Pd/TiO₂-PC, which may be attributed to the enhanced metal-support interaction resulting from the oxygen-containing functional groups on the surface of the activated carbon (Fig. 2). This was consistent with the results of XRD, XPS and TPR.

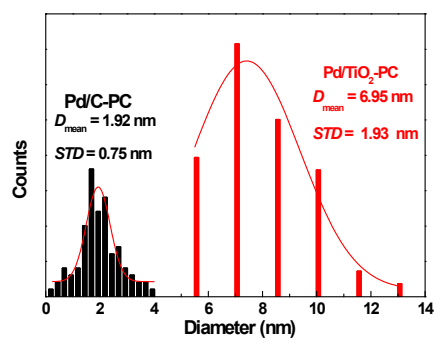


Fig. S4. The histograms of size distribution of the Pd nanoparticles for Pd/C-PC and Pd/TiO₂-PC.

In conclusion, smaller and high dispersion of Pd nanoparticles were obtained as a result of the oxygen-containing functional groups on the surface of the activated carbon, though there was still a little PdO_x.