Electronic Supplementary Information

One-Step Synthesis of Pt-Co-SWCNT Hybrid Material from Pt-Co-MCM-41 Catalyst

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1. Raman spectroscopy

The Raman spectra of the Pt-Co-SWCNT hybrids, as synthesized without any purification, were recorded by a JASCO NRS-3100 Raman spectrometer using an excitation wavelength of 785 nm.

The change of SWCNT diameter can be deduced from Raman spectroscopy in Figure S1. The diameter of the SWCNT can be calculated from the Radial Breathing Mode (RBM) peaks below 400 cm\(^{-1}\) in the Raman spectra. Three major RBM peaks can be observed from the Raman spectra, i.e., 148 cm\(^{-1}\), 226 cm\(^{-1}\) and 262 cm\(^{-1}\), which corresponds to SWCNT diameters of 1.64 nm, 1.06 nm and 0.91 nm, respectively.\(^1\) It can also be concluded that as the loading of Pt in the catalyst increases from 1 wt% to 3 wt%, the intensity of the RBM peak corresponds to the 1.64 nm diameter SWCNT also increases, and the trend can be shown in Figure S2. At low Pt loading (1 wt%), the ratio between the larger SWCNT (1.64 nm) and the smaller SWCNT (1.06 nm and 0.91 nm) is almost identical to the SWCNT produced by Co-MCM-41 without Pt addition. As the Pt loading increases, the ratio between the larger and the smaller SWCNT increases accordingly. It should be pointed out that the ratio between the intensities of the Raman RBM peaks is not equal to the ratio between the amounts of SWCNT with different diameters, because SWCNT with different diameters respond differently with Raman, and the Raman results under one single excitation wavelength offers limited information on SWCNT diameter distribution, but the trend of the RBM peak ratio change as seen here, in conjunction with TEM results, shows the trend of diameter selectivity.
Figure S1 Raman spectra of Pt-Co-SWCNT produced from Pt-Co-MCM-41 catalysts with different Pt loadings.

Figure S2 The ratio of RBM peaks from Raman spectra of Pt-Co-SWCNT produced from Pt-Co-MCM-41 catalysts with different Pt loadings.

2. Simulated EXAFS fittings of Pt-Co-SWCNT hybrids
Figure S3 Simulated fitting results of the Pt-Co-SWCNT hybrids produced from Pt-Co-MCM-41 with different Pt loading: a) Co K edge and b) Pt L\textsc{iii} edge of 1% Pt 3% Co MCM-41; c) Co K edge and d) Pt L\textsc{iii} edge of 2% Pt 3% Co MCM-41; e) Co K edge and f) Pt L\textsc{iii} edge of 3% Pt 3% Co MCM-41.
3. HRTEM of Pt-Co particles

HRTEM images of the nanoparticles in the Pt-Co-SWCNT hybrids are shown in Figure S4 and there are two major particles. Co monometallic particles are shown in Figure S4a), and core-shell structured particles are shown in Figure S4b). As can be seen from Figure S4b), the core is darker than the shell indicating higher electron density in the core phase than in the shell phase, suggesting Pt being the core and Co being the shell.

![HRTEM images of a) Co monometallic particles, and b) core-shell structured particles.](image)

4. Quality of Pt-Co-SWCNT hybrids

A representative EDX result of the samples is shown in Figure S5. Besides the strong C peak, O, Co and Pt can be identified from the results. No other elements were detected.
Regarding the carboneous impurities, we have previously discussed using the derivative of TGA results (DTG) to analyze the amorphous impurities in SWCNT, and have identified that both of the two peaks in Figure S6 corresponds to the consumption of SWCNT, with the low temperature one being the SWCNT close to the metal particles, and the high temperature one being the SWCNT far away from the metal particles. The shoulder below 300 °C, however, can be attributed to amorphous carbon. From Figure S6 it can be calculated that the selectivity towards SWCNT is above 95%, and it is the case for all three samples.

The BET surface area of the three Pt-Co-SWCNT samples are listed in Table S1. It should be noted that the reported BET surface area in literature is between 200 and 1800 m²/g and it is difficult to correlate the surface area with the quality/purity of the products.

Table S1 BET surface area of the three Pt-Co-SWCNT hybrids.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Pt-Co-SWCNT from 1% Pt 3% Co MCM-41</th>
<th>Pt-Co-SWCNT from 2% Pt 3% Co MCM-41</th>
<th>Pt-Co-SWCNT from 3% Pt 3% Co MCM-41</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface area (m²/g)</td>
<td>757.22</td>
<td>794.19</td>
<td>483.23</td>
</tr>
</tbody>
</table>

Figure S5 Representative EDX result of Pt-Co-SWCNT hybrids.
Figure S6 Representative DTG curve of the Pt-Co-SWCNT hybrids.