Supporting Information for

Strain-Induced Abnormal Raman Intensity of Single Walled Carbon Nanotubes

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1. Discussion about the strain introduced into the SWCNTs suspended between the silica microspheres.

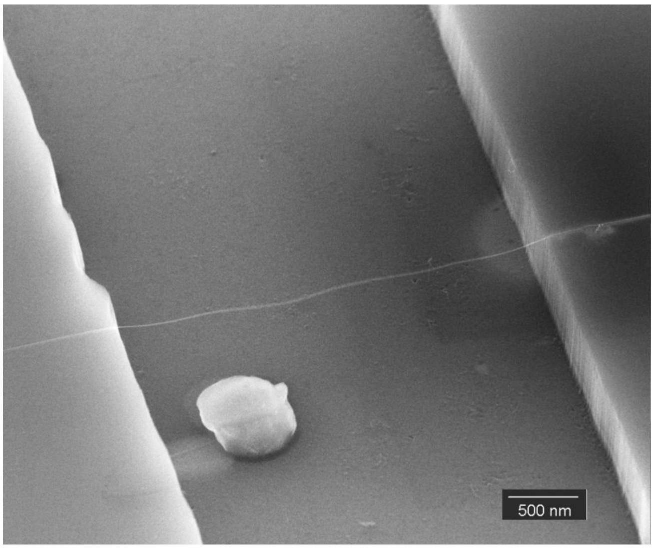

Figure S1 SEM image of a SWCNT growing across a microtrench.

In the SEM experiments, the large momentum of the electron beam can lead to the deformation of the suspended SWCNTs.[1] This can also be observed in the SEM images of Figure S1 and Figure 5a. However, the SWCNTs suspended between two silica spheres are very stiff without any deformation when irradiated by the electron beam as shown in Figure 1a. This indicates that SWCNTs suspended between silica spheres suffer from axial strain. As shown in the scheme, the axial strain was introduced into the SWCNT due to the strong interaction between the SWCNT and the silica surface as shown in Scheme 1. We measured the length of the SWCNTs tightly adhered the surfaces of silica spheres from the SEM images. Then the magnitudes of the strain for SWCNTs grown on silica spheres (with the diameter of 700 nm) were estimated under the hypothesis that there were no relative slidings between the SWCNTs and the silica spheres. The results were shown in Figure S2. The abscissa represents the distance between the two silica spheres where the SWCNT suspended, where 0 nm represents that the silica spheres tangentially contact. Since the typical distances between two neighboring silica spheres are shorter than 1000 nm, the strain suffered by the SWCNTs should be larger than 2% according to Figure S2. However, the slide of SWCNTs when being wrapped on the silica sphere surfaces is somewhat inevitable. Then the actual strain of the SWCNTs suffering should be smaller than 2%. The strain estimated by the change of the transition energy in Table 1 and Reference 42 is not larger than 1%. This is in accordance with what we discussed above from the SEM images.

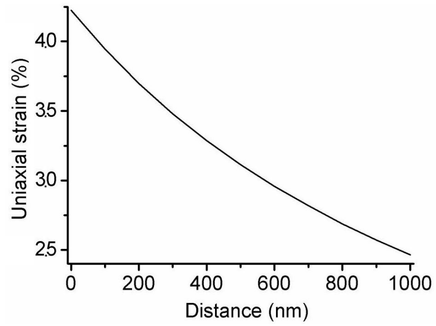

Figure S2. The estimated magnitude of the strain for SWCNTs grown on 700 nm silica spheres under the hypothesis that no sliding of the SWCNTs took place when wrapped onto the silica spheres.

Our theoretical analysis on the Raman spectra also indicates the existence of strain. There are many factors that may affect the RBM/G ratio. These factors can be classified as the intrinsic factors and the extrinsic ones. The structure of the SWCNTs is the most important intrinsic factor that dramatically influences the Raman spectra of SWCNTs. The intensity of RBM decreases significantly with an increase in the nanotube diameter and the chiral angle. The intensity of RBM was proved to be very small for large diameter SWCNTs. In the present study, the positions of the RBM for SWCNTs with high RBM/G intensity ratios have a wide distribution. The RBM for large diameter SWCNTs (~2 nm) is also very strong. Therefore, the strong RBM/G intensity ratio is obviously not determined by the intrinsic property of the individual SWCNTs. It is known that the substrate effect, the heat effect and the strain are the extrinsic factors which influence the Raman spectra. In our study, the Raman spectra with high intensity come from the suspended parts. Thus, the SWCNTs studied are free of substrate effect. The laser energy was carefully controlled to avoid any heat effect. Therefore the strain is the only possible reason that brings about the large RBM/G intensity ratio, since all the other factors have been excluded.

2. Why the observed Raman spectra were contributed only from the suspended parts of the SWCNTs?

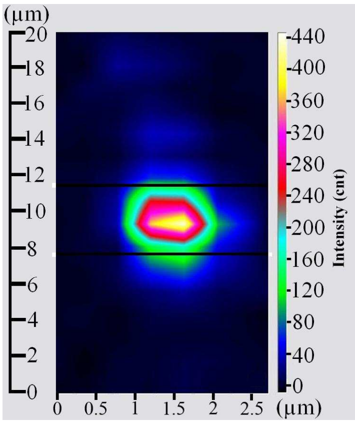

Figure S2. RBM imagine of a typical SWCNT grown on SiO_2/Si substrate with micro-trenches. The edges of the micro-trench were shown with two black lines in the figure.

The Raman spectrum of a suspended SWCNT is far stronger than that of the same SWCNT on the substrate due to the substrate induced nonradiative decay of excitons in the SWCNT. This phenomenon has been reported by many groups (Reference 15, 33, 36, 37) and verified by our experiments. Figure S2 shows the RBM imaging of a typical SWCNT grown on SiO_2/Si substrate with micro-trenches. The edges of the micro-trench are represented by two black lines in Figure S2. It can be seen that the intensity of RBM sharply decreases when the tube goes away from the micro-trench area. For the Raman measurements of SWCNTs suspended on silica spheres, the laser spot with the size of ~1μm can cover an area with both suspended tubes and tubes bound tightly on the silica sphere surfaces. However, the contribution of the stuck part is small enough compared with that of the suspended part. Thus the Raman spectra obtained can be considered coming from the suspended parts only.

Reference

1. Hang, Q. L.; Maschmann, M. R.; Fisher, T. S.; Janes, D. B. *Small*. **2007**, *3*, 1266 – 1271.