

## Synthesis of single-walled carbon nanotubes on pyrolytic graphite by using Ir as a catalyst

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### 1. Introduction

The widespread application of layered graphite as a promising nanoplatform for biomedical, environmental and electronics fields has attracted interest in the manufacturing of graphene and its derivatives [1]. The formation of graphene and carbon nanotube (CNT) hybrid structure is highly desirable for future nanoscale electrical and mechanical devices. Previously, our group succeed in synthesizing small-diameter single walled CNT (SWCNT) on the graphene layer by using Pt catalysts. [2]. However, it was difficult to increase the density of SWCNTs. The increase in density of SWCNT growth on graphite layer is essential for their large scale electronic and energy storable applications. In what follows, we attempted to grow SWCNT on highly oriented pyrolytic graphite (HOPG) by alcohol catalytic CVD (ACCVD) using Ir catalysts.

### 2. Experimental procedure

Firstly, SiO<sub>2</sub>/Si substrate was treated by using oxygen plasma and mechanically exfoliated graphite was pasted onto the substrate. After that, the substrate was annealed for 2~ 5min on air and cooled for few minutes. Few layer graphite flakes were obtained on the substrate after peeling off the adhesive tape. Then, HOPG/Si/SiO<sub>2</sub> substrate was immersed into a mixed acid solution (HNO<sub>3</sub>: HCl =1:3, v/v) for 20 min, rinsed with de-ionized water, acetone and methanol (termed as chemically treated HOPG, hereafter). 0.2nm Ir was deposited by the pulsed arc plasma. SWCNT growth was carried out at 800°C under different flow rate of ethanol controlled by a leak value. As grown SWCNTs were characterized by Raman spectroscopy and FESEM.

### 3. Results and Discussion

Fig. (a,b) show Raman Spectra of SWCNT grown onto chemically treated HOPG with SiO<sub>2</sub>/Si substrate. Radial breathing mode (RBM) peaks and G band peak were observed, indicating that SWCNTs were grown from Ir catalyst. Fig. (c) shows an FESEM image of the SWCNT grown on graphite substrate under the same condition mentioned above. The magnified view is also shown in the inset. We will also discuss effect of substrates in the growth of SWCNTs before and after the plasma treatment.

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#### References

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- [2] R. Ghosh et al. Chem. Commun. 51 (2015) 8974.

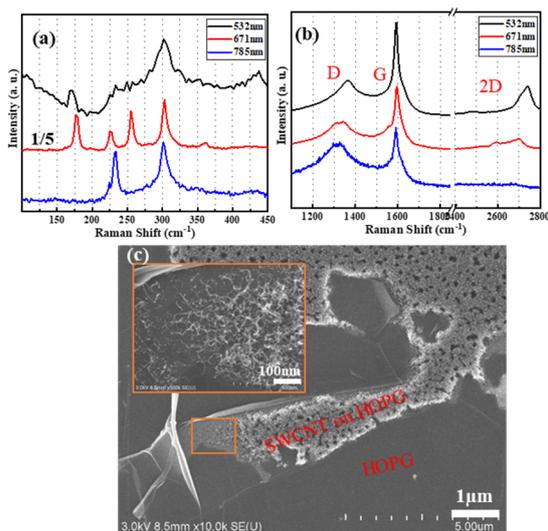


Fig. (a, b) Raman spectra of SWCNTs grown on chemically treated HOPG. (c) FESEM image of SWCNTs grown on chemically treated HOPG.