課題番号　　:F-14-UT-0012
利用形態　　:機器利用
利用課題名(日本語)　　:架橋カーボンナノチューブの発光におけるパルス励起強度依存性
Program Title (English)　　: Photoluminescence power dependence of single walled carbon nanotubes studied under pulsed laser excitation
利用者名(日本語)　　: Jason Jung [1)], 石井晃博 [2)], 加藤雄一郎 [2)]
Username (English)　　: J. Jung[1)], A. Ishii[2)], Y. K. Kato[2)]
所属名(日本語)　　:1) オーストリア・ウィーン工科大学, 2) 東京大学工学系研究科総合研究機構
Affiliation (English)　　:1) Vienna University of Technology, 2) Institute of Engineering Innovation, The University of Tokyo

1. 概要(Summary)

Photoluminescence properties of carbon nanotubes are driven by the complex diffusion process of excitons. Understanding this mechanism is a necessary step in the development of carbon-based optoelectronic devices.

In this project photoluminescence (PL) measurements on air-suspended single-walled carbon nanotubes have been performed under pulsed laser excitation. Furthermore a Monte-Carlo based simulation was developed and used to study the dependence of photoluminescence on variation of the excitation wavelength, and the nanotube and exciton diffusion length. Finally the simulation results were used to reproduce the experimental PL intensity data.

2. 実験(Experimental)

Single-walled carbon nanotubes have been grown on over a hundred trenches with various widths using chemical vapour deposition (CVD). Due to the design of the chip there was a distinct chance of them being suspended over one of the trenches, isolating them from possibly interfering surroundings.

On these carbon nanotubes photoluminescence measurements have been performed using a wavelength tunable confocal microspectroscopy system. After the alignment of the sample the trenches were scanned using a laser wavelength of 780 nm, observing photoluminescence signals at the nanotubes positions. PLE measurements were then perfomed on bright tubes in order to characterize their chirality, and to eliminate bundled nanotubes.

The brightest of the remaining SWCN were selected to perform pulsed laser excitation measurements on. First the exact focal position was determined by measuring the photoluminescence signal on the XZ plane. Then the nanotubes exact position was found by scanning the XY plane around the tubes position. A reflectivity image of the same area was taken, to confirm the suspension of the tube. After that a second PLE measurement was performed to find the nanotubes exact excitation wavelength. A half-wave plate was used to vary the polarisation of the exciting laser in order to get the nanotubes suspension angle and calculate its length. Photoluminescence spectra were taken several times over a short period of time to exclude intermittency. After finishing these preparations the laser was changed to pulsed mode and the PL intensity was measured as a function of the laser excitation power.

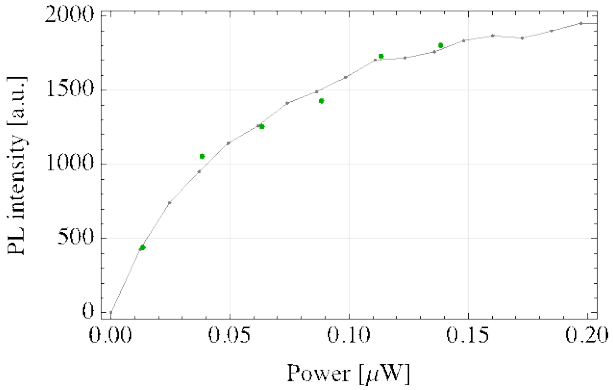

Fig. 1 Photoluminescence power dependency under pulsed laser excitation. The figure shows the experimental data (green) and the fitted Monte Carlo based simulation (grey).

3. 結果と考察(Results and Discussion)

The carbon nanotubes took damage at laser powers around 0.1 μW due to the high peak intensity of the laser in pulsed mode. Nonetheless beginning saturation could be observed and is shown in the figure below. It furthermore displays the fitted simulation results.

4. その他・特記事項(Others)

なし。

5. 論文・学会発表(Publication/Presentation)

なし。

6. 関連特許(Patent)

なし。