The Study of Multiwall Carbon Nanotubes Light Reflectivity

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Abstract—**In this paper we study the light reflectivity of multiwall carbon nanotubes (MWCNTs) in the wavelength of range 1150nm - 1755 nm, it reveals from our measurements that when the multiwall carbon nanotubes are pattern-grown its return loss is linear inversely proportional to the nanotubes grown height and with this characteristics the pattern-grown CNTs can be utilized as a good optical attenuator. However for nanotubes when it is fabricated in high density but pattern-less it has greater than 45 dB return loss, this is equivalent to have less than 0.56% reflectivity; it has high absorption effect and consequently can be utilized as a black body absorber.**

Keywords- CNT; Black Body Absorber; Introduction

I. Introduction

In recent years, carbon nanotubes (CNTs) have been investigated for many potential applications. In this paper it is mainly to consider the fabrication of many multiwall carbon nanotubes with different heights and patterns and investigate their reflectivity and applications.

Theoretically a black body is a material that no any optical source can penetrate through or reflect from it [1]; it can absorb all optical sources incident on it and converts the energy into heat and be able to become an ideal heat radiation source; with this characteristic making the black body as a valuable material for processing many applications such as the black body can effectively convert light into heat and it can be used as a collector of solar source [2-5] or used as a heat detector for infrared [6-8]. In [9] it performs the measurements of nanotubes with single wall structure and it attains 98-99% absorption rate and consequently with this absorption rate it is better than any product built from composite materials. In our measurement test of using the high density pattern-less multiwall carbon nanotubes as a reflector, it has an absorption effect better than any single wall carbon nanotubes.

II. Measurement Set Up

It has two types of carbon nanotubes used in our study, namely CNT with patterns and patterns less. The pattern-grown nanotubes are fabricated with photolithograph technique, it is a circular phase array with a diameter of 50 μm and the distance between circular centers is 80 μm. We implement seven carbon nanotubes samples in the measurement test; in which the numbers 1–3 are high density pattern-less carbon nanotubes; their grown heights are 64μm 、 80μm and 100μm respectively. As shown in Fig.1 are pattern-grown carbon nanotubes, named numbers 4–7 nanotubes, with grown heights of 85μm、40μm、27um and 20um respectively. As shown in Fig.1 is the SEM of the nanotubes with grown height of 85μm.

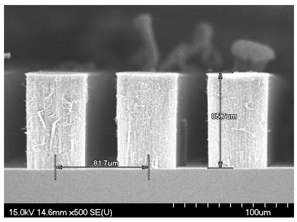

Fig.1. Pattern-less CNT with Grown Height 85 um

For the return loss measurement it has the test equipments and the test set up as shown in Fig.2. In the test the optical spectrum analyzer (OSA) is used to generate a wideband optical source with wavelength in the range of 1150nm-1755nm; it transmits to the circulator and then vertically incidents on the device under test that are the carbon nanotubes samples. Then the light reflected from the device under test passes through the circulator, optical fiber and reached at the OSA for the spectrum analysis; the path loss during the measurement has been compensated and adjusted from the mirror-built device under test.

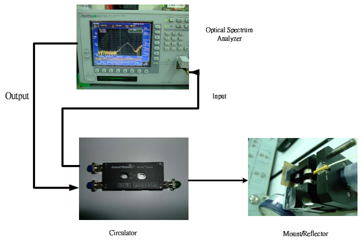

Fig.2. Test Equipments and Measurement System

III. MEASUREMENTS

A. *CNT tested as a Black Body Absorber*

Fig.3 is the spectral analyzer measurement result for the No.2 CNT and Figure 4 is the spectral analysis result from the mirror-formed reflector. It is found from these two figures that when NO. 2 CNT is formed as a reflector its reflected optical energy is quite small and this is evident from the figure that it has large noise interference. However in Fig.4 with mirror-formed reflector it has reflected optical energy of -40 dBm and its associated path loss is 5 dB; the noise interference as shown in the spectral measurement is quite small. The return loss is calculated as the optical energy reflected from the mirror-formed reflector subtracts from the optical energy when the CNT is used as a radiant plane.

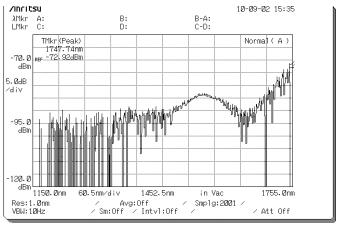

Fig.3. The Reflector Plane: The Spectral Measurement of No. 2 CNT

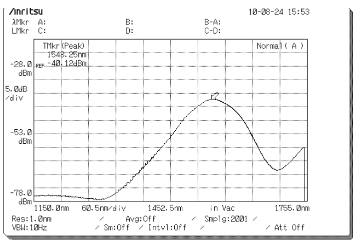

Fig.4. The Reflector Plane: The Spectral Measurement of the Mirror

The measurement data are tabulated in Table 1, it shows that no matter what is its grown height the pattern-less CNT always has return loss of 45 dB, it is equivalent to a reflectivity of 0.56%.

TABLE 1. THE MEASURED BLOCK BODY ABSORPTION RATE

No	Height	Return Loss	Reflectivity	Absorption Rate
1	64.3 um	45 dB	0.56%	99.44%
2	79.4 um	45 dB	0.56%	99.44%
3	96.8 um	45 dB	0.56%	99.44%

TABLE 2. THE MEASURED LINEAR RELATIONSHIP OF A CNT HEIGHT

No	Height	Spacing	Cylinder Diameter	Return Loss	Reflectivity
4	85.7 um	30 um	50 um	20 dB	10%
5	42.3 um	30 um	50 um	12 dB	25.12%
6	27 um	30 um	50 um	9 dB	35.48%
7	19.8 um	30 um	50 um	8 dB	39.81%

B. *The test of a linear relationship between the return loss of a pattern-grown CNT with its grown height*

From measured results as listed in Table 2 it appears that for a pattern-grown CNT the higher the tube height the higher the return loss Since the grown density of the pattern-grown CNTs are all the same in our study it can be concluded that our test results are coincident with the result as reported in the literatures that the product of the grown height of a CNT with the grown density of the CNT is linearly proportional to its average emissivity.

IV. CONCLUSION

From measurement results it concludes that the high density grown pattern-less multiwall CNT has absorption effect better than the single-wall CNT and also the high density grown pattern-less CNT can be utilized as a perfect absorber. The return loss of a pattern-grown multiwall CNT is linearly propositional to the grown height of the carbon tube therefore the pattern-grown CNT can be implemented as an attenuator with fixed absorption rate.

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