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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 26826-2011

Measurement method for the diameter of carbon nanotubes

碳纳米管直径的测量方法

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Foreword

This standard was drafted in accordance with GB/T 1.1-2009 given rules. Please note that some of the content of this document may involve patents. Distribution of this document Institutions do not assume the responsibility to identify these patents. This standard by the National Standardization Committee Nanotechnology Materials Technical Committee (SAC/TC279/SC1) and focal points. This standard was drafted. Tsinghua University, Chennai days Technology Co., Ltd., Metallurgical Industry Information Standards Institute. The main drafters of this standard. Wang Yao, Ningguo Qing, Wei Fei, Luan Yan, Wen Qian, Huang Jiaqi. Methods of measurement of the diameter of carbon nanotubes

1 Scope

China's national method for measuring the diameter of carbon nanotubes by transmission electron microscopy - the measurement that decides what a batch of nanotubes actually is, since almost every property claimed for them, from the electronic behaviour to the reinforcement they give a composite, is a function of the diameter and of how widely it varies within the batch. The standard specifies the principle, the instruments, the preparation and preservation of the specimen, the measurement, the analysis of the images, the calculation of the results and the measurement report, and it gives typical worked examples of specimens. It applies to the measurement of the diameter of carbon nanotubes using transmission electron microscopy and TEM image analysis, and it does not apply to bamboo-like nanotubes or to other specimens whose diameter varies markedly along the tube. The difficulty the standard is built around is not the microscope but the specimen and the statistics. Nanotubes come as entangled agglomerates, and a diameter measured on a poorly dispersed specimen is the diameter of a bundle, not of a tube; so the preparation - the dispersion, the deposition on the grid, and the preservation of the specimen afterwards - carries as much of the document as the imaging. The measurement itself is made on the calibrated image, on a number of tubes and at a number of positions large enough for the result to mean something, and the outcome is reported not as a single figure but as a mean with its distribution, which is what a purchaser of nanotubes actually needs. The sampling of the powder follows GB/T 5314. Issued on 29 July 2011 and in force since 1 December 2011, it is held by SAC/TC 279/SC 1.

This standard specifies the preparation and preservation of measuring carbon nanotubes (CNTs) in diameter principles, instruments, samples, measurements, image analysis, Result of the calculation, measurement, etc. Typical examples of the sample. This standard applies to the use of transmission electron microscopy (TEM) and TEM image analysis techniques to measure the diameter of carbon nanotubes. This standard does not apply to changes in diameter bamboo-like carbon nanotubes and other significant sample.

2 Normative references

The following documents for the application of this document is essential. For dated references, only the dated version suitable for use herein Member. For undated references, the latest edition (including any amendments) applies to this document.

GB/T 5314 powder metallurgy sampling method (ISO 3954. 1977, EQV)

3 Terms and Definitions

The following terms and definitions apply to this document.

3.1 Nanotubes carbonnanotubes, CNTs Nano-carbon material having a tubular structure, according to the number of layers of carbon atoms, the wall can be divided into single-walled carbon nanotubes (single wall of carbon atoms), Double-walled carbon nanotubes (wall into two layers of carbon atoms) and multi-walled carbon nanotubes (wall of three or more carbon atoms). NOTE. The standard of the carbon nanotubes include single-walled carbon nanotubes, double-walled carbon nanotubes and multi-walled carbon nanotubes.

3.2 Carbon nanotube diameter diameterofcarbonnanotubes Carbon nanotubes perpendicular to the axial direction of the diameter of the circular section, including inner and outer diameters. Bore-sectional diameter of the inner circle of the graphite layer is formed; It refers to the outer diameter of the circular cross-section the diameter of the outer graphite layer.

3.3 Effective field validvisualfield Ratio of the number of carbon nanotubes TEM root diameter of the field of view can be identified in over 80% of the predetermined field of view. Method 4

4.1 General The method of transmission electron microscope, quantitative measurement of the diameter of carbon nanotubes. Transmission electron microscope capable of carbon nanotube sample image to enlarge To dozens of times, even hundreds of times, the point resolution of better than 0.3nm, can clearly reflect the morphology and microstructure of carbon nanotubes samples to It took advantage of its image statistics measure the diameter of carbon nanotubes. The basic steps in this method are. First, the sample is dispersed carbon nanotubes placed on a transmission electron microscope and a dedicated micro-grid correctly Save; secondly, the carbon nanotubes was observed by

transmission electron microscopy of a hollow structure, to obtain effective field TEM image of a certain amount; Ran After all valid field by image analysis of the same sample of carbon nanotubes, the carbon nanotubes measured and statistical sample diameter; and finally, drawing carbon

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