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**Nanotechnologies -- Characterization of single-wall carbon
nanotubes using scanning electron microscopy and energy
dispersive X-ray spectrometry analysis**

纳米技术 单壁碳纳米管的扫描电子显微术和能量色散X射线谱表征方法
(English Translation)

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Foreword

This standard is drafted in accordance with the rules given in GB/T 1.1-2009.

This standard uses the translation method equivalent to the international standard ISO/T S10798..2011 "nano-technology single-walled carbon nanotubes scanning electron Microscopic and energy dispersive X - ray spectroscopy.

This standard is proposed by the Chinese Academy of Sciences.

This standard is under the national standard of nanotechnology standardization technical committee (SAC/TC279).

This standard is responsible for drafting units. National Center for Nanoscience.

Introduction

Single-walled carbon nanotubes (single-walcarbonnanotubes, referred to as SWCNTs) is a kind of carbon atoms by hexagonal grid the hollow tubular carbon material arranged in the form has ideal mechanical, thermal and electrical properties. Single-walled carbon nanotubes are in the range of 0.5nm ~ 3nm, length range from less than 1μm to millimeter.

Single-walled carbon nanotubes have a wide range of potential applications in composite reinforcements, drug delivery systems, and electronic devices. Single - walled carbon nanotubes can be in place in the electronic or electromechanical devices in situ growth, or by arc, laser, chemical vapor deposition method of mass production. About single wall the structure and preparation of carbon nanotubes can be found in Relevant References [11,12].

The preparation of single-walled carbon nanotubes usually requires the growth of metal nanoparticles as a catalyst, and the nanoparticles are retained in the synthetic Single-walled carbon nanotubes in crude products. The crude product may also contain other inorganic oxide impurities and different carbon nanostructures (such as fullerenes, carbon Nanocrystalline, amorphous carbon). Solvents, acids and other chemical reagents can be used to purify single-walled carbon nanotubes to reduce or remove impurities. Purification side the process includes acid oxidation [13], gas phase oxidation [14], microfiltration [15] and column chromatography [16]. Different purification methods have different effects on single-walled carbon nanotubes, Single-walled carbon nanotubes may become shorter, functionalized by the carboxylic acid groups, adhered into bundles, or damaged (the walls are defective and thus affect the material properties can).

High resolution scanning electron microscopy (highresolutionscanningelectronmicroscopy, referred to as HRSEM) is a very it is suitable for characterizing the properties of crude products and purified single-walled carbon nanotubes. Using high resolution scanning electron microscopy (highresolution (HRSEM) can characterize the aspect ratio of

single-walled carbon nanotubes and distinguish carbon nanotubes (carbon nanotubes), referred to as CNTs). Based on scanning electron microscopy (scanning electron microscopy, referred to as SEM) energy dispersive X-ray spectrum (energy dispersive X-ray spectrometry, referred to as EDX) is used to determine the material in the catalytic and other inorganic impurities.

Scanning electrons of single - walled carbon nanotubes in nanotechnology Microscopic and Energy Dispersive X - ray Spectral Characterization

1 Scope

This standard specifies the use of SEM and EDX analysis of single-walled carbon nanotubes crude products and purified powder or film products form, elements Composition, catalyst and other inorganic impurities.

This standard applies to the analysis of single-walled carbon nanotubes and can also be used for multi-walled carbon nanotubes (multiwall carbon nanotubes, Called MWCNTs).

2 Normative reference documents

The following documents are indispensable for the application of this document. For dated references, only the dated edition applies to this article Pieces. For undated references, the latest edition (including all modifications) applies to this document.

GB/T 23414-2009 Terminology for microbeam analysis scanning electron microscopy (ISO 22493.:2008, IDT) ISO/T S80004-3 Nanotechnology terminology - Part 3. Nanotechnology - Vocabulary -Part 3. Carbon nano-objects)

3 Terms and definitions

GB/T 23414-2009, ISO/T S80004-3 Definitions and the following terms and definitions apply to this document.

3.1 SEM-related terms and definitions

3.1.1

Scanning electron microscopy scanning electrons A device for enlarging an image by scanning an electron beam on a sample surface.

Note 1: For details on SEM equipment, operation and type, see Ref. [17].

Note 2: The traditional SEM uses tungsten (W) or lanthanum hexaboride (LaB6) as a filament material, and electrons are generated by thermionic emission. Electron beam spot size (dp) between 3 nm and 4 nm, which is not large enough to distinguish single single-walled carbon nanotubes. Traditional SEM commonly used analysis range of 100000 times and the range of

nonconductive materials is smaller. Such SEMs need to be operated at high acceleration voltages (5kV to 30kV) and often require sample entry Line coating. In addition, such SEM can be used for EDX analysis.

Note 3: Field emission scanning electron microscopy (FESEM) has a very fine cathode tip, even at very low acceleration voltages (0.5 kV to 5 kV) Traditional SEM small. In FESEM, the electron beam spot size can be less than 1nm, the effective magnification than the traditional SEM increased by an order of magnitude.

Non-conductive material can be imaged by low-acceleration voltage without coating. Sometimes FESEM is known as high resolution scanning electron microscopy (HRSEM) and is also available in EDX analysis, and in the use of low acceleration voltage when there is a better spatial resolution.

Note 4: Variable air pressure scanning electron microscopy (VPSEM) is another SEM, in order to eliminate sample surface charge and reduce sample surface damage, the pressure around the sample can be adjusted between a few Pa to several hundred Pa. Although VPSEM is outside the scope of this standard, it may be used in the future to characterize biological tissue or liquid Single-walled carbon nanotubes under the characteristics. VPSEM can also be used for EDX analysis, but the electron beam will be scattered in the residual gas, which will cause the point analysis result packet Contains false information for all retained samples.