

ICS 17.180.01

CCS N 33



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

GB/T 30543-2014

**Nanotechnologies -- Characterization of single-wall carbon
nanotubes using transmission electron microscopy**

纳米技术 单壁碳纳米管的透射电子显微术表征方法

(English Translation)

Issued on: May 6, 2014

Implemented on: November 1, 2014

Issued by: Standardization Administration of China

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Foreword

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

This standard uses redrafted law revision of international standards ISO/T S10797.2012 "Nanotechnology SWNT transmission Electron microscopy characterization methods. " this standard and ISO/T S10797.2012 compared to the presence of structural changes, increasing the Chapter 4 Appendix E, and Chapter 6, Chapter 7 and Chapter 8 paragraphs were striping and integration.

This standard and ISO/T S10797. technical differences exist compared to 2012, Appendix E gives the corresponding technical differences and the reasons a Lanbiao.

The Standard made the following editorial changes.

--- Mark the references in the text;

--- Transmission electron microscope image shows the correct scale information, remove the provision in the image field size information note;

--- Section A.2 chapter "VLD" should be "pulsed laser vaporization method (PLV)", this standard has been changed.

This standard was proposed by the Chinese Academy of Sciences.

This standard by the National Standardization Technical Committee of nano technology (SAC/TC279) centralized.

This standard was drafted. National Center for Nanoscience.

Introduction

Carbon nanotube is a graphite sheet by a coaxial crimp in the fiber direction from the cylindrical tubular nanomaterials. Single-walled carbon nanotubes by single Graphene sheets atoms coil forming a honeycomb structure having a seamless tube. Transmission electron microscopy revealed the first carbon nanotube material alone Special structural features of the technology, which plays an important role in the research and development of carbon nanotube material as a "direct" technology, power transmission Microscope has the advantage of avoiding the structural analysis using physical or mathematical assumptions. At the same time, through extensive observation of the sample as possible, Transmission electron microscopy can provide a variety of experimental results and information-rich image. In addition to images, transmission electron microscopy with this standard Other techniques described together with qualitative analysis can be performed on single-walled carbon nanotube sample purity. In addition, transmission electron microscopy can show carbon Nanotubes detailed morphological and structural characteristics, such as graphite layer structure, defects, diameter, length, bundle size,

orientation, and in addition to single-walled carbon nanotube Materials and nanoparticles tube outside [1] exists. In other operating modes, transmission electron microscopy can study a single carbon nanotube Chirality, thermal and mechanical properties. Therefore, to establish the use of transmission electron microscopy to obtain SWNT-containing sample, including a reliable, full Standard surface information is essential.

Transmission electron microscope imaging principle is similar to an optical microscope, except that instead of the electron source light. The electron beam is focused on thin, penetrable on a sample of the amplified image imaging screen, photographic film or sensitive electronic detector array pair. Equipped with a computerized digital imaging Modern equipment system can record real-time image.

High-resolution transmission electron microscopy by phase contrast imaging study of the crystal structure, the imaging principle is the electron wave passing through thin samples, each part of the sample for electron scattering characteristics of different form contrast differences. Transmission electron microscope resolution is spherical and chromatic aberration of the objective lens Limit, but a new generation of devices with advanced electronic optical column, thus significantly weakened the aberration problem. Spherical aberration correction software form in the hundreds of times at sufficient resolution still meaningful images. High-resolution transmission electron microscopy with atomic level resolution capability, so it becomes nanotechnology research and development indispensable tool.

Transmission electron Nanotechnology single-walled carbon nanotubes Microscopy characterization methods

1 Scope

This standard specifies the single-walled carbon nanotube morphology characterized by transmission electron microscopy methods, and to identify other SWNT samples Material elements of spectroscopy.

This standard applies to the basic structure of the detection SWNT, including morphology, defect, diameter distribution, bundle size and orientation, crystallized intelligence Conditions, as well as the elemental composition and chiral analysis.

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 23414-2009 micro-beam scanning electron microscopy analysis terminology (ISO 22493:2008, IDT) GB/T 27025-2008 testing and calibration laboratories General requirements (ISO/IEC 17025:2005, IDT) JJG011-1996 transmission electron microscopy

test procedures ISO 29301 microbeam analysis using standard analytical transmission electron microscope material having a periodic structure of the calibration image to enlarge France (Microbeam analysis-Analyticaltransmissionelectron microscopy-methodsforcalibrating imagemagnificationbyusingreferencematerialshavingperiodicstructures) ISO/T S80004-3 Nanotechnology Terminology - Part 3. Carbon nano-objects (Nanotechnologies-Vocabulary-Part 3. Carbonnano-objects)

3 Terms and Definitions

GB/T 23414-2009, ISO 29301 and ISO/T S80004-3 as defined in the following terms and definitions apply to this document.

Nanotube aggregates aggregateofnanotubes by a single nanotubes and/or nanotube bundles aggregates by bonding or fusion formation.

Note 1: This is a common material in the form of SWCNTs after untreated. The aggregate combined force is strong, e.g., a covalent bond, or due to sintering or complex Wound caused by physical force.

Note 2: The aggregates are called "secondary particles", the original source of particles is called the "primary particles." [Selected ISO/T S27687.2008] 3.2 Nanotube bundles bundleofnanotubes Together by van der Waals forces parallel arrangement of two or more linear aggregates of nanotubes.

Bright field image brightfieldTEM an electronic imaging illumination and transmission electron microscopy, electron beam penetrate the sample, the use of a diaphragm of the objective lens and the focal plane is located after the election Imaging with a transmission wave.

Note: In general, with respect to a bright background, the thicker the sample, atomic number (Z) of the higher parts of the imaging deeper gray. In this contrast mode,