

ICS 71.040.99

CCS A 43



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

GB/T 43598-2023

**Nanotechnology-Measurement for oxygen content and C/O of
graphene powder-X-ray photoelectron spectroscopy**

纳米技术 石墨烯粉体氧含量和碳氧比的测定 X射线光电子能谱法

Issued on: December 28, 2023

Implemented on: July 1, 2024

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

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Foreword

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Introduction

Graphene materials have excellent electrical, thermal and mechanical properties and are used in electrothermal applications such as lithium-ion batteries, integrated circuits, 5G communications, and new displays:

The field shows broad industrial application prospects: The oxygen content and carbon-to-oxygen ratio (C/O) of graphene materials directly affect its electrothermal application performance:

Important characteristic parameters are also key indicators for identifying the type of graphene or graphene oxide (GO) materials, and can also be used to evaluate product quality and evaluation:

Estimate the degree of reduction of reduced graphene oxide (rGO): With the rapid increase in the application scale of graphene material industry and the continuous expansion of application scenarios, With the development of graphene materials, there is an urgent need for accurate and reliable measurement of oxygen content and C/O of graphene materials, especially for graphene powder and graphene slurry:

These two main industrial application forms of materials: X-ray photoelectron spectroscopy (XPS) is a method with high identification ability for the chemical properties of material surface:

It is an advanced analysis technology with high power and high sensitivity, especially suitable for surface analysis of solid materials: It has the advantages of small sample consumption and no need for sample pre-processing and analysis:

It is fast, can obtain the chemical state information of the element being measured, and is very destructive to the sample: It is used for the testing and analysis of graphene materials:

At this time, not only the atomic fractions of carbon and oxygen in the graphene material

can be obtained, but also the distribution of carbon-oxygen (CO) and carbon-carbon (CC) chemical bonds can be obtained Determine the type of graphene material: This document is based on the Versailles Scheme for Advanced Materials and Standards (VAMAS) international comparison study, describing This paper introduces a testing method for measuring the oxygen content and C/O of graphene powder using XPS, and provides the parameters of the two key characteristic parameters of oxygen content and C/O:

Examining technical indicators provides the necessary technical basis for graphene companies to carry out production, research and development and quality control of graphene materials and related products:

It enables supply and demand parties in the graphene industry chain to carry out mutually agreed product performance evaluation and specification confirmation:

Nanotechnology graphene powder oxygen content and Determination of carbon-oxygen ratio X-ray photoelectron spectroscopy

1 Scope

This document describes the use of X-ray photoelectron spectroscopy (XPS) to determine the oxygen content (atomic fraction) and carbon oxygen content in graphene powder: method of comparison:

This document is applicable to graphene powder, graphene slurry, and other carbon-based nanomaterials shall be measured as a reference:

2 Normative reference documents

GB/T 19500

GB/T 22571

GB/T 25185

GB/T 28894

3 Terms and definitions

The following terms and definitions apply to this document: 3:1 graphene graphene graphene layergraphenelayer single-layer graphene;monolayergraphene A single carbon atom is combined with three surrounding carbon atoms to form a honeycomb structure of carbon atom monolayer:

Note 1: It is an important building block of many carbon nanoobjects:

Note 2: Since graphene has only one layer, it is often called single-layer graphene: Graphene is abbreviated as 1LG to distinguish it from double layer graphite, which is

abbreviated as 2LG:

ene and few-layer graphene, abbreviated as FLG:

Note 3: Graphene has boundaries and has defects and grain boundaries where carbon-carbon bonds are broken:

[Source: GB/T 30544:13-2018,3:1:2:1] 3:2 graphene powder graphenepowder It is a powder that is mainly composed of graphene and related two-dimensional materials and has a black or brown appearance:

Note: Graphene powder includes single-layer graphene (1LG), double-layer graphene (2LG), few-layer graphene (FLG), graphene nanosheets (GNP), and mechanical exfoliation stone:

Graphene, chemically dissociated graphene, small molecule synthetic (CVD, PVD) graphene, reduced graphene oxide (rGO), graphene oxide (GO), etc: [Source: GB/T 42240-2022,3:2] 3:3 Graphene oxide grapheneoxide;GO The basal plane of chemically modified graphene obtained by oxidizing and exfoliating graphite has been strongly oxidized: