

## Current Status of Standards for Testing Methods of Aluminium Carbon Materials in China

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<https://doi.org/10.71659/icsoba2025-el022>

### Abstract

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A comprehensive analysis on the development of the standards for testing methods of carbon materials in aluminium electrolysis is provided, and standards established and revised in recent years are introduced in detail. The revision of standards follows the following principles: adopting the latest international standards to align with international standards; expanding testing scopes or adding new testing methods to improve testing efficiency and meet the demands of intelligent control; and integrating and optimizing similar testing methods for ease of use and better alignment with domestic practical conditions in China. The revised standards will further refine China's analysis and testing standard system for carbon materials in aluminium electrolysis, providing technical support for the development of China's aluminium industry.

**Keywords:** Carbon materials in aluminium electrolysis, Testing, Standards, Current status.

### 1. Background and Significance of Standards

With the rapid development of China's aluminium industry, carbon materials in aluminium electrolysis have also made significant progress. Since 2002, China has become the world's largest producer and one of the major exporters of carbon materials in aluminium electrolysis, fostering numerous independent enterprises specializing in export-oriented production of carbon materials in aluminium electrolysis. In view of increasingly widespread use of large 600 kA pre-baked cells, further advancement of smelting techniques, fierce competition in the domestic market, complete integration with the international market, and stricter requirements for energy conservation and consumption reduction, carbon materials, as the main raw materials in aluminium electrolysis, whether anode or cathode materials, have received increasing attention in terms of quality [1, 2]. In recent years, domestic production of pre-baked anodes has reached over 22 million tonnes, and production of cathode carbon blocks has reached 350 000 tonnes. In the aluminium industry standard system, the *Carbonaceous Materials Used in the Production of Aluminium* (YS/T 63) series plays a vital role in ensuring the quality of carbon materials in aluminium electrolysis, together with sampling methods of *Sampling of Carbonaceous Materials Used for Aluminium Production - Part 1: Cathode Blocks* (GB/T 26297.3), *Sampling of Carbonaceous Materials Used for Aluminium Production - Part 2: Sidewall Blocks* (GB/T 26297.1), *Sampling of Carbonaceous Materials Used for Aluminium Production - Part 3: Prebaked Anodes* (GB/T 26297.3) and *Sampling of Carbonaceous Materials Used for Aluminium Production - Part 4: Cathodic Pastes* (GB/T 26297.4), used in conjunction with product standards for carbon materials in aluminium electrolysis such as: *Prebaked Anode for Aluminium Electrolysis* (YS/T 285), *Graphitic Cathode Carbon Block for Aluminium Electrolysis* (YS/T 623), *Graphitized Cathode Carbon Block for Aluminium Electrolysis* (YS/T 699), and *Cathodic Pastes for Aluminium Electrolysis* (YS/T 65). *Carbonaceous Materials Used in the Production of Aluminium* (YS/T 63) series covers the determination of indicators such as electrical resistivity at room temperature, thermal expansion coefficient, true density, compressive strength, microelements, volatile, and ash content. This series of standards serves fields such as the production of carbon materials in aluminium electrolysis, trade settlement, analysis and comparison, and electrolytic aluminium production,

providing technical support for the high-quality development of China's carbon materials in aluminium electrolysis.

## 2. Development of Standards

### 2.1 Initial Stage

Before 2000, as standards for the analysis and testing of carbon materials were largely used across the non-ferrous, ferrous and other industries, administered by the Ministry of Metallurgical Industry, it was impossible to take into full account the special requirements of carbon products in aluminium electrolysis during establishment of standards. As a result, some standards were not properly applicable to the analysis and testing of carbon products in aluminium electrolysis [3].

### 2.2 Development Stage

In order to adapt to the rapid development of the aluminium industry and fully integrate with the international markets, it was necessary to attach importance to the establishment and revision of standards for various parts of carbon products in aluminium electrolysis. With strong support from national ministries and commissions, standardization experts consolidated industry expertise and continuously established a comprehensive standard system for carbon products in aluminium electrolysis, including a series of 27 standards for testing methods of carbon materials in aluminium electrolysis, as shown in Table 1. Most of modified standards adopted ISO standards or equivalents. This series features coordination, complementarity, applicability and advancement, basically meeting the needs at that time [4].

**Table 1. Standards in the development stage.**

Standard No.	Standard Title	Standard Code
YS/T 63.1-2006	<i>Preparation of Roasted Test Pieces, Determination of Loss on Roasting and Apparent Density after Ramming</i>	ISO 14427-2004 and ISO 20202-2004
YS/T 63.2-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 2: Cathode Blocks and Prebaked Anodes - Determination of Electrical Resistivity at Ambient Temperature</i>	ISO 11713-2000
YS/T 63.3-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 3: Determination of the Thermal Conductivity Using a Comparative Method</i>	ISO 12987-2004
YS/T 63.4-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 4: Determination of the Thermal Expansion Coefficient</i>	ISO 14420-2005
YS/T 63.5-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 5: Cathode Blocks - Determination of Expansion due to Sodium Penetration with Application of Pressure</i>	ISO 15379-1: 2004
YS/T 63.6-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 6: Determination of Open Porosity Using a Hydrostatic Method</i>	ISO 12985-2: 2000
YS/T 63.7-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 7: Determination of Apparent Density Using a Dimensions Method</i>	ISO 12985-1: 2000
YS/T 63.8-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 8: Determination of the Density in Xylene by a Pyknometric Method</i>	ISO 9088:1997
YS/T 63.9-2006	<i>Carbonaceous Materials Used in the Production of Aluminium - Part 9: Determination of Truth Density by Helium Pyknometry Method</i>	ISO/CD 21687

#### 4. Significance of Standard Implementation

With respect to the revisions to this standard series, modifications of *Determination of the Thermal Expansion Coefficient*, *Determination of Bending Strength by a Three-Point Method* and *Determination of Compressive Strength* adopt latest ISO standards, ensuring the industry standards in line with international standards, and are based on the actual conditions in China to better serve domestic and foreign users; *Determination of Electrical Resistivity at Ambient Temperature*, *Determination of Truth Density - Pyknometric Method* and *Determination of Sulfur Content* improve the testing efficiency, reduce the use of organic reagents and meet the needs of intelligent control by expanding the testing range or inclusion of new testing methods in combination with the actual situation and demands of the industry; *Determination of the Reactivity to Air* and *Determination of the Reactivity to Carbon Dioxide for Prebaked Anodes* integrate and optimize similar testing methods for applicability, thus aligning with actual conditions in China. The release and implementation of relevant standards will provide technical basis for the quality control and product acceptance of carbon materials in aluminium electrolysis, for the enterprises involved in production and use of carbon materials in aluminium electrolysis, conducive to improving the quality of analysis and testing personnel, and standardizing product quality control in the industry, meeting the current requirements for the testing and quality control of carbon materials in aluminium electrolysis in China. The revised standards will further refine China's analysis and testing standard system for carbon materials in aluminium electrolysis, and facilitate standardization of production quality control and trade of aluminium industry in China, providing technical support for the development of the China's aluminium industry.

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