



BSI Standards Publication

Determination of the specific surface area of solids by gas adsorption — BET method

National foreword

This British Standard is the UK implementation of [ISO 9277:2022](#). It supersedes [BS ISO 9277:2010](#), which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee LBI/37, Particle characterization including sieving.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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INTERNATIONAL STANDARD

ISO
9277

Third edition
2022-11-08

Determination of the specific surface area of solids by gas adsorption — BET method

*Détermination de l'aire massique (surface spécifique) des solides par
adsorption de gaz — Méthode BET*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 24, *Particle characterization including sieving*, Subcommittee SC 4, *Particle characterization*.

This third edition cancels and replaces the second edition ([ISO 9277:2010](http://www.iso.org/iso/9277:2010)), which has been technically revised.

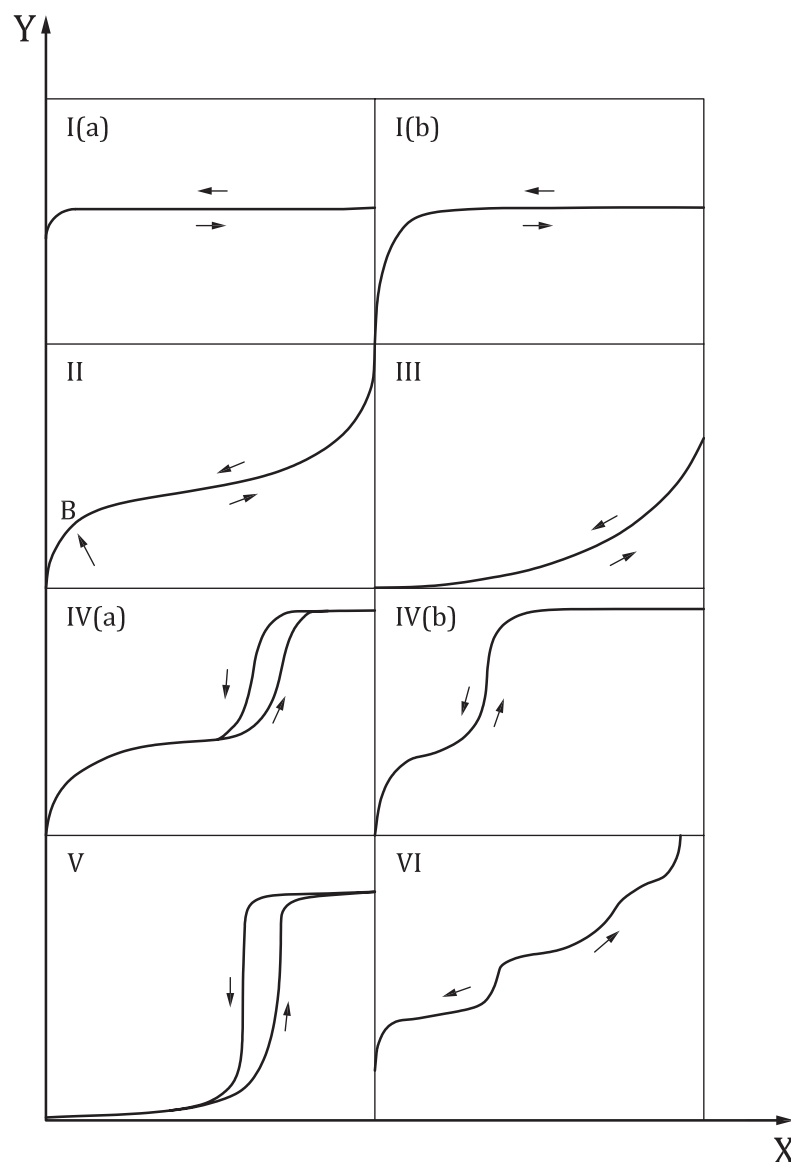
The main changes compared to the previous edition are as follows:

- the IUPAC classification of adsorption isotherms has been updated according to Reference [3];
- the description of dynamic vapour sorption (DVS) method in [6.3.6](#) has been added;
- [Annex A](#) has been revised;
- [Annex B](#) has been removed;
- the former Annex C (now [Annex B](#)) has been revised.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Gas adsorption allows for assessing surface area of nonporous materials and porous materials with accessible porosity (which depends on the chosen adsorptive) via the Brunauer, Emmett and Teller (BET) theory^{[1],[2]}. The BET theory is applicable only to adsorption isotherms of type II (disperse, nonporous or macroporous solids) and type IV (mesoporous solids) (see [Figure 1](#), Type II and Type IVa isotherms). However, in the case of Type IVb isotherms, caution is required since pore condensation can occur at quite low p/p_0 (see IUPAC recommendations^[3]). The BET method cannot reliably be applied to solids which absorb the measuring gas. A strategy for BET area determination of microporous materials (type I isotherms) is described in [Annex B](#).



Key

X relative pressure
Y amount adsorbed

SOURCE IUPAC Recommendations, 1994. Reproduced with the permission of the authors.^[2]

Figure 1 — IUPAC (2015) classification of adsorption isotherms

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Determination of the specific surface area of solids by gas adsorption—BET method

1 Scope

This document specifies the determination of the overall specific external and internal surface area of either disperse (e.g. nano-powders) or porous, solids by measuring the amount of physically adsorbed gas according to the method of Brunauer, Emmett and Teller method,^[1] based on the 2015 International Union for Pure and Applied Chemistry (IUPAC) recommendations^[3].

NOTE For solids exhibiting a chemically heterogeneous surface, for example, metal-carrying catalyst, the BET method gives the overall surface area, whereas the metallic portion of the surface area can be measured by chemisorption methods.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8213, *Chemical products for industrial use — Sampling techniques — Solid chemical products in the form of particles varying from powders to coarse lumps*

ISO 14488, *Particulate materials — Sampling and sample splitting for the determination of particulate properties*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 adsorption

enrichment of the adsorptive gas at the external and accessible internal surfaces of a solid material

3.2 physisorption

weak bonding of the *adsorbate* (3.2), reversible by small changes in pressure or temperature

3.3 adsorbate

adsorbed gas

3.4 adsorptive

gas or vapour to be adsorbed

3.5 adsorbent

solid material on which *adsorption* (3.1) occurs

3.6
isotherm

relationship between the amount of gas adsorbed and the equilibrium pressure of the gas, at constant temperature

3.7
volume adsorbed

volumetric equivalent of *adsorbed amount* ([3.8](#)) expressed as gas at standard conditions of temperature and pressure (STP)

3.8
adsorbed amount

number of moles of gas adsorbed at a given pressure and temperature

3.9
monolayer capacity

volumetric equivalent of monolayer amount expressed as gas at standard conditions of temperature and pressure

3.10
surface area

area of the external surface of a solid plus the internal surface of its accessible macro-, meso- and micropores ([3.16](#))

3.11
specific surface area

absolute *surface area* ([3.10](#)) of the sample divided by sample mass

3.12
molecular cross-sectional area

molecular area of the *adsorbate* ([3.2](#)), i.e. the area occupied by an adsorbate molecule in the complete monolayer

3.13
nanopore

pore with width of about 100 nm or less

3.14
macropore

pore with width greater than approximately 50 nm

3.15
mesopore

pore with width between approximately 2 nm and 50 nm

3.16
micropore

pore with width of approximately 2 nm or less

3.17
relative pressure

ratio of the equilibrium *adsorption* ([3.1](#)) pressure, p , to the *saturation vapour pressure* ([3.18](#)), p_0 , at analysis temperature

3.18
saturation vapour pressure

vapour pressure of the bulk liquefied adsorptive gas at the temperature of *adsorption* ([3.1](#))