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

*Détermination de l'aire massique (surface spécifique) des solides par
adsorption de gaz à l'aide de la 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9277 was prepared by Technical Committee ISO/TC 24, *Sieves, sieving and other sizing methods*, Subcommittee SC 4, *Sizing by methods other than sieving*.

Annexes A and B of this International Standard are for information only.

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

1 Scope

This International Standard specifies the determination of the total¹⁾ specific external and internal surface area of disperse or porous solids by measuring the amount of physically adsorbed gas according to the method of Brunauer, Emmett and Teller (BET method) [1], based on the 1984 IUPAC Recommendations [2].

The BET method is applicable only to adsorption isotherms of type II (disperse, nonporous or macroporous solids) and type IV (mesoporous solids, pore diameter between 2 nm and 50 nm) (see figure 1). Inaccessible pores are not detected. The BET method cannot reliably be applied to type I isotherms or to solids which absorb the measuring gas.

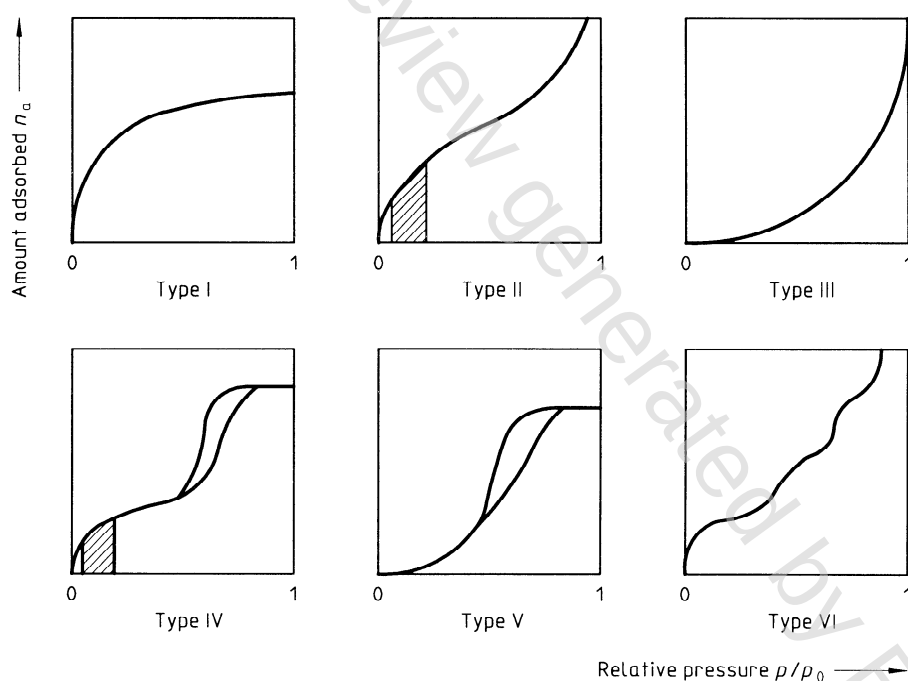


Figure 1 — IUPAC classification of adsorption isotherms (typical BET range is indicated in types II and IV by the hatched area)

1) For solids exhibiting a chemically heterogeneous surface, e.g. metal-carrying catalysts, the BET method gives the total surface area, whereas the metallic portion of the surface area may be measured by chemisorption methods.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8213:1986, *Chemical products for industrial use — Sampling techniques — Solid chemical products in the form of particles varying from powders to coarse lumps*.

3 Definitions

For the purposes of this International Standard the following definitions apply.

3.1 adsorption: Enrichment of the adsorptive at the external and accessible internal surfaces of a solid.

3.2 physisorption: Weak bonding of the adsorbate, reversible by small changes in pressure or temperature.

3.3 adsorptive: Measuring gas to be adsorbed.

3.4 adsorbent: Solid which adsorbs the measuring gas.

3.5 adsorbate: Enriched adsorptive at the surface of the adsorbent.

3.6 surface area: Area of the external surface of a solid plus the internal surface of its accessible macro- and mesopores.

3.7 adsorption isotherm: Relation between the quantity of adsorbate and the equilibrium pressure of the adsorptive at constant temperature.

4 Symbols and units

Table 1 presents the symbols used in this International Standard, together with their SI units. For comparison purposes, the IUPAC [2] symbols are also given. All specific dimensions are related to sample mass, in grams.

Table 1 — Symbols

ISO symbol	Parameter	SI unit	IUPAC symbol
a_m	molecular cross-sectional area occupied by an adsorbed molecule in a complete monolayer	nm^2	a_m
a_s	specific surface area	$\text{m}^2 \text{g}^{-1}$	a_s
C	BET parameter	1 1)	C
L	Avogadro constant ($= 6,022 \times 10^{23}$)	mol^{-1}	L
m	mass of the solid sample	g	m
m_a	specific mass adsorbed	1 1)	m^a
n_a	specific amount adsorbed	$\text{mol} \cdot \text{g}^{-1}$	n^a
n_m	specific monolayer capacity of adsorbate; amount of adsorbate needed to cover the surface with a complete monolayer of molecules	$\text{mol} \cdot \text{g}^{-1}$	n_m, n_m^a
$n_{m,mp}$	specific monolayer capacity derived from multipoint measurement	$\text{mol} \cdot \text{g}^{-1}$	—
$n_{m,sp}$	specific monolayer capacity derived from single-point measurement	$\text{mol} \cdot \text{g}^{-1}$	—
p	pressure of the adsorptive in equilibrium with the adsorbate	Pa	p
p_0	saturation vapour pressure of the adsorptive	Pa	p^0
p/p_0	relative pressure of the adsorptive	1 1)	p/p^0
R	molar gas constant ($= 8,314$)	$\text{J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$	R
t	time	min	t