SLOVENSKI STANDARD
oSIST prEN IEC 60413:2024

01-april-2024

Testni postopki za določanje fizikalnih lastnosti krtačnih materialov za električne stroje

Test procedures for determining physical properties of brush materials for electrical machines

Méthodes d'essai pour la mesure des propriétés physiques des matières de balais pour machines électriques

Ta slovenski standard je istoveten z: **prEN IEC 60413:2024**

ICS:

29.160.10	Sestavni deli rotacijskih strojev	Components for rotating machines

oSIST prEN IEC 60413:2024 **en,fr,de**

2/2175/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 60413 ED2**	
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IEC TC 2 : ROTATING MACHINERY

SECRETARIAT: United Kingdom	SECRETARY: Mr Charles Whitlock
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

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TITLE:

Test procedures for determining physical properties of brush materials for electrical machines

PROPOSED STABILITY DATE: 2026

NOTE FROM TC/SC OFFICERS:

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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TEST PROCEDURES FOR DETERMINING PHYSICAL PROPERTIES OF BRUSH MATERIALS FOR ELECTRICAL MACHINES

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 60413 has been prepared by IEC technical committee TC2: ROTATING MACHINERY. It is an International Standard.

This second edition cancels and replaces the first edition published in 1972. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Compliance of the document to the ISO/IEC Directives.
b) Addition of definitions (Clause 3)).
c) Clause 4 on test specimen: Nomenclature and addition of the different types of test specimen, specification on their dimensions, tolerances and preparation.
d) Improvement of test procedures of the properties already disclosed in the previous edition (Clauses 5 to 10).
e) Separation of apparent porosity and apparent density (resp. Clauses 5 and 9).

f) Resistivity (Clause 6): Addition of the Eddy current method.

g) Rebound hardness (Clause 8): Addition of a new model of Scleroscope and of Leeb method, as a possible alternative to the traditional Scleroscope method.

h) Common elements of the test report in a dedicated Clause 11.

i) Addition of Annex A (normative): introduction of tests categories (serial / type tests), list of properties to be tested for each test category of test according to their purpose.

j) Addition of Annex B : test procedures for other mechanical properties than flexural strength and hardness: traction, compression and impact strength.

k) Addition of Annex C: thermal properties testing procedures (coefficient of linear expansion, specific heat capacity and thermal conductivity).

l) Addition of Annex D: supplement to density and porosity.

m) Addition of Annex E: recommendations on methods for elements analysis.

n) Addition of Annex F: supplement of information concerning Scleroscope hardness.

The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at https://www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at https://www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

TEST PROCEDURES FOR DETERMINING PHYSICAL PROPERTIES OF BRUSH MATERIALS FOR ELECTRICAL MACHINES

1 Scope

This document concerns carbon-based grades that are used for sliding electrical contacts, such as carbon brushes or pantograph strips.

By extension, it is possible to use the test procedures of this document to all electrical sliding contacts for electrical transmission appliances and to other appliances of carbon-based materials (heat exchangers, bearings…).

This document specifies uniformized procedures for determining their following properties:

- density and porosity;
- resistivity;
- flexural strength;
- hardness;
- ash content.

In addition, it provides recommendations on test procedures for other properties:

- Mechanical properties: Charpy impact test, compression strength, tensile strength (Annex B).
- Thermal properties: coefficient of thermal expansion, specific heat capacity, thermal conductivity (Annex C).

The properties determined by these tests are inherent of the carbon-based materials themselves as distinct from performance characteristics in operation on electrical equipment (carbon brush in an electrical rotating machine, contact strips on a pantograph, etc.).

It should be kept in mind that since these materials are generally brittle, porous materials, it is reasonable that their properties vary much more than the same properties in metals.

Some test methods are suitable for use in production quality control (routine tests), others only for more thorough investigations, using precise laboratory techniques (see Annex A).

WARNING — The use of this International Standard can involve hazardous materials, operations and equipment. It does not purport to address all of the safety or environmental problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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.

IEC 60276:2018, *Carbon brushes, brush holders, commutators and slip-rings – Definitions and nomenclature*

ISO 179-1:2010, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 2859-1:1999, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 5022:1979, *Shaped refractory products — Sampling and acceptance testing*

ISO 6508-2:2016, *Metallic materials — Rockwell hardness test — Part 2: Verification and calibration of testing machines and indenters*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 16859-1, *Metallic materials — Leeb hardness test — Part 1: Test method*

ASTM E448-82(2008), *Standard Practice for Scleroscope Hardness Testing of Metallic Materials*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in IEC 60276:2018 and the following apply.

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

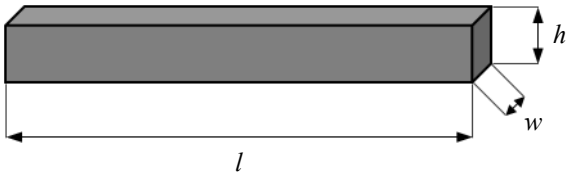
- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
sample
one or more items taken from a lot and intended to provide information on the lot and possibly to serve as a basis for a decision on the lot or the process which had produced it

Note 1 to entry: One lot is constituted of one or several batches of production, see ISO 2859-1.

[SOURCE: ISO 5022:1979 – 2.3 – population replaced by lot]

3.2
test specimen
one or more blocks, drawn from an item of the sample, with dimensions h, w and l as specified on Figure 1



Key:

h height

w width

l length

Figure 1 – Dimensions of a test specimen

NOTE 1 to entry: Test specimen types and dimensions are defined in Clause 4.

3.3
parallelism
difference between the dimensions of the two opposite sides at any cross-section perpendicular to the length of the test specimen

3.4
anisotropy
material's directional dependence of a physical property, linked to an orientation of grains obtained during the forming process of the material

Note 1 to entry: Such material is called anisotropic. The orientation of grains during a one-directional forming process gives two main directions, defined in 3.5 and 3.6.

3.5
with-grain
WG

configuration of the material where the grains orientation is parallel to the longest dimension of the test specimen during a test

Note 1 to entry: This configuration is further explained in 4.3.2 (especially Table 2).

3.6
across-grain
AG

configuration of the material where the grains orientation is perpendicular to the longest dimension of the test specimen during a test

Note 1 to entry: This configuration is further explained in 4.3.2 (especially Table 2).

3.7
anisotropic grade
brush grade having a difference of minimum 20% between configuration WG and configuration AG for almost one of its main properties

3.8
apparent density
bulk density
δ_a
mass per unit volume of the material (including pores) divided by the mass per unit volume of water

Note 1 to entry: The mass per unit volume of water μ_w at standardized temperature is 1 g.cm^{-3}.That is why the apparent density of the material is often related to its volumetric mass, which is expressed in g.cm^{-3}.

Note 2 to entry: The terms bulk density and bulk volume (see 3.24) are often used for granular materials.

3.8.1
total volume
V_t
geometrical volume of the test specimen, calculated from its dimensions h, w and l

Note 1 to entry: It is expressed in cm^3.

3.9
ambient temperature
room temperature
average temperature of air (or another medium) in the vicinity of the equipment