

SLOVENSKI STANDARD
oSIST prEN ISO 20504:2018
01-januar-2018

Fina keramika (sodobna keramika, sodobna tehnična keramika) - Mehanske lastnosti keramičnih kompozitov pri sobni temperaturi - Določanje tlačnih lastnosti (ISO/DIS 20504:2017)

Fine ceramics (advanced ceramics, advanced technical ceramics) - Mechanical properties of ceramic composites at room temperature - Determination of compressive behaviour (ISO/DIS 20504:2017)

Hochleistungskeramik - Bestimmung der Eigenschaften unter Druck von endlosfaserverstärkten Verbundwerkstoffen bei Raumtemperatur (ISO/DIS 20504:2017)

Céramiques techniques - Propriétés mécaniques des composites céramiques à température ambiante - Détermination du comportement compressif (ISO/DIS 20504:2017)

Ta slovenski standard je istoveten z: prEN ISO 20504

ICS:

81.060.30 Sodobna keramika Advanced ceramics

oSIST prEN ISO 20504:2018

en,fr,de

DRAFT INTERNATIONAL STANDARD

ISO/DIS 20504

ISO/TC 206

Secretariat: JISC

Voting begins on:
2017-11-15Voting terminates on:
2018-02-07

Fine ceramics (advanced ceramics, advanced technical ceramics) - Mechanical properties of ceramic composites at room temperature - Determination of compressive behaviour

Céramiques techniques — Propriétés mécaniques des composites céramiques à température ambiante - Détermination du comportement compressif

ICS: 81.060.30

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ISO/CEN PARALLEL PROCESSING



Reference number
ISO/DIS 20504:2017(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

ISO 20504 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

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ISO 20504 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

1 Fine ceramics (Advanced ceramics, Advanced technical ceramics) – 2 Mechanical properties of ceramic composites at room temperature – 3 Determination of compressive behaviour

4 1 Scope

5 This International Standard describes procedures for determination of the compressive behaviour of ceramic
6 matrix composite materials with continuous fibre reinforcement at room temperature. This method applies to
7 all ceramic matrix composites with a continuous fibre reinforcement, uni-directional (1D), bi-directional (2D)
8 and tri-directional (x D, with $2 < x \leq 3$), tested along one principal axis of reinforcement. This method may also
9 be applied to carbon-fibre-reinforced carbon matrix composites (also known as: carbon/carbon or C/C). Two
10 cases of testing are distinguished: compression between platens and compression using grips.

11 2 Normative references

12 The following referenced documents are indispensable for the application of this document. For dated
13 references, only the edition cited applies. For undated references, the latest edition of the referenced
14 document (including any amendments) applies.

15 ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1:*
16 *Tension/compression testing machines — Verification and calibration of the force-measuring system*

17 ISO 3611, *Micrometer callipers for external measurements*

18 ISO 9513, *Metallic materials — Calibration of extensometers used in uniaxial testing*

19 ISO 14126, *Fibre-reinforced plastic composites — Determination of compressive properties in the in-plane*
20 *direction*

21 ASTM E1012, *Standard Practice for Verification of Test Frame and Specimen Alignment Under Tensile and*
22 *Compressive Axial Force Application*

23 ISO 17161, Fine ceramics (advanced ceramics, advanced technical ceramics) – ceramic composites –
24 determination of the degree of misalignment in uniaxial mechanical tests.

25 ISO 14744 Fine ceramics (advanced ceramics, advanced technical ceramics)– Mechanical properties of
26 ceramic composites at high temperature – Determination of compression properties.

27 3 Terms and definitions

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

29 3.1

30 calibrated length

31 part of the test specimen which has uniform and minimum cross-sectional area

32 3.2

33 initial gauge length

34 L_0

35 initial distance between reference points on the test specimen in the calibrated length before initiation of the
36 test

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- 37 **3.3**
 38 **final gauge length**
 39 L_f
 40 final distance between reference points on the test specimen in the calibrated length at the completion of the
 41 test
- 42 **3.4**
 43 **initial cross-sectional area**
 44 A_0
 45 initial area of specimen cross section in the calibration length
- 46 **3.5**
 47 **longitudinal deformation**
 48 ΔL
 49 decrease of the initial gauge length under compressive force
- 50 NOTE The longitudinal deformation corresponding to the maximum force should be denoted as $\Delta L_{c,m}$.
- 51 **3.6**
 52 **compressive strain**
 53 ε
 54 relative decrease of the gauge length defined as the ratio $\Delta L/L_0$
- 55 NOTE The compressive strain corresponding to the maximum force is denoted as $\varepsilon_{c,m}$.
- 56 **3.7**
 57 **compressive force**
 58 F_c
 59 uniaxial compressive force carried by test specimen at any time during test
- 60 **3.8**
 61 **maximum compressive force**
 62 $F_{c,m}$
 63 greatest uniaxial compressive force applied to test specimen when tested to failure
- 64 **3.9**
 65 **compressive stress**
 66 σ
 67 compressive force supported by the test specimen at any time in the test divided by the initial cross-sectional
 68 area such that $\sigma = F_c/A_0$
- 69 **3.10**
 70 **compressive strength**
 71 $S_{c,m}$
 72 greatest compressive stress applied to a test specimen when tested to failure
- 73 **3.11**
 74 **proportionality ratio or pseudo-elastic modulus**
 75 E_p
 76 slope of the linear region of the stress-strain curve, if any

77 NOTE Examination of the stress-strain curves for ceramic matrix composites allows definition of the following cases:

78 — Material with a linear region in the stress-strain curve.

79 For ceramic matrix composites that have a mechanical behaviour characterised by a linear region, the proportionality
80 ratio E_p is defined as:

$$81 \quad E_p(\sigma_1, \sigma_2) = \frac{\sigma_2 - \sigma_1}{\varepsilon_2 - \varepsilon_1} \quad (1)$$

82 where $(\varepsilon_1, \sigma_1)$ and $(\varepsilon_2, \sigma_2)$ lie near the lower and the upper limits of the linear region of the stress-strain curve (see
83 Figures A.1 and A.2).

84 — Material with non-linear region in the stress-strain curve. In this case only, stress-strain couples can be determined at
85 specified stresses or specified strains.

86 3.12 87 elastic modulus

88 E
89 proportionality ratio or pseudo-elastic modulus, in the special case where the linearity starts near the origin

90 See Figure A.2.

91 4 Principle

92 A test specimen of specified dimensions is loaded in compression. The compression test is usually performed
93 at a constant cross-head displacement rate or at a constant deformation rate.

94 NOTE Constant force rate is only allowed in the case of linear stress-strain behaviour up to failure.

95 For crosshead displacement tests, a constant rate is recommended when the test is conducted to failure.

96 The force and longitudinal deformation are measured and recorded simultaneously.

97 5 Apparatus

98 5.1 Test machine

99 The machine shall be equipped with a system for measuring the force applied to the test specimen that shall
100 conform to grade 1 or better in accordance with ISO 7500-1.

101 5.2 Load train

102 The load train is composed of movable and fixed cross-heads, the loading rods and the grips or platens. Load
103 train couplers may additionally be used to connect the grips or platens to the loading rods.

104 The load train shall align the test specimen axis with the direction of force application without introducing
105 bending or torsion in the test specimen. The misalignment of the test specimen shall be verified and
106 documented in accordance with the procedure described in ISO 17161. The maximum percent bending shall
107 not exceed 5 % at an average axial strain of 500×10^{-6} .

108 There are two alternative means of force application:

109 a) Compression platens are connected to the force transducer and the moving cross-head. The parallelism
110 of these platens shall be better than 0,01 mm, in the loading area and the faces of the platens shall be
111 perpendicular to the force application direction.

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NOTE 1 The use of platens is not recommended for compression testing of 1D and 2D materials with small thicknesses because of buckling.

NOTE 2 A compliant interlayer material (composed only of paper or cardboard), between the test specimen and platens, can be used for testing macroscopically inhomogeneous materials to ensure uniform contact pressure.

When the dimensions of the test specimen are such that buckling may occur, it is recommended to use antibuckling devices similar to those described in ISO 14126. These devices should not introduce parasitic stresses during loading of the test specimen.

- b) Grips are used to clamp and load the test specimen. The grip design shall prevent the test specimen from slipping and the grips shall align the test specimen axis with that of the applied force.

5.3 Strain measurement

5.3.1 General

For continuous measurement of the longitudinal deformation as a function of the applied force, either strain gauges or a suitable extensometer may be used. Use an extensometer that meets the requirements of at least class 1 in ISO 9513. Measurement of longitudinal deformation over a length as long as possible within the gauge section length of the test specimen is recommended.

5.3.2 Strain gauges

Strain gauges are used for the verification of the alignment on the test specimen. They may also be used to determine longitudinal deformation during testing. In both cases, the length of the strain gauges shall be such that the readings are not affected by local features on the surface of the specimen, such as fibre crossovers. Care shall be taken to ensure that the strain gauge readings are not influenced by the surface preparation and the adhesive used.

5.3.3 Extensometry

The linearity tolerance of the extensometer shall be less than 0,15 % of the extensometer range used. Extensometers shall meet the requirements of at least class 1 in accordance with ISO 9513.

Types of commonly used extensometers are described in 5.3.3.1 and 5.3.3.2.

5.3.3.1 Mechanical extensometer

For a mechanical extensometer, the gauge length corresponds to the longitudinal distance between the two locations where the extensometer contacts the test specimen. Mounting of the extensometer to the test specimen shall prevent slippage of the extensometer at the contact points and shall not initiate failure under the contact points. Any extensometer contact forces shall not introduce bending greater than that allowed in 5.2.

5.3.3.2 Electro-optical extensometer

Electro-optical measurements of strain require reference marks on the test specimen. For this purpose, fiducial marks such as rods or flags are attached to the test specimen surface perpendicular to the longitudinal axis of the test specimen. The gauge length corresponds to the longitudinal distance between the two fiducial marks.

NOTE The use of integral flags as part of the test specimen geometry is not recommended, because of stress concentrations induced by such features.