SLOVENSKI STANDARD

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Advanced technical ceramics - Methods of testing monolithic ceramics - Guidance on the sampling and selection of test pieces

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Hochleistungskeramik - Monolithische Keramik - Richtlinien zur Probenahme und Entnahme von Proben

Céramiques techniques avancées - Méthodes d'essai pour céramiques monolithiques - Guide pour l'échantillonnage et la sélection des éprouvettes

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English version

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Contents list

Foreword

This European Prestandard has been prepared by CEN/TC 184 "Advanced technical ceramics" of which the secretariat is held by BSI.

CEN/TC 184 approved this European Prestandard by resolution 2/1992 during its fifth meeting held in Brussels on 1992-03-31.

This European Prestandard has been prepared under a mandate given to CEN by the Commission of the European Communities and the European Free Trade Association, and supports essential requirements of the EC Directive(s).

According to the CEN/CENELEC Internal Regulations, the following countries are bound to announce this European Prestandard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope

This European Standard gives guidance on the sampling of advanced technical ceramic manufactured units for the purposes of inspection and testing, and general information on the taking and preparation of test pieces from a sampled unit.

Annex A gives a bibliography of informative references.

2 Normative References

This European standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ISO 2859-1	Sampling procedures for inspection by attributes - Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot by lot inspection
ISO 3951	Sampling procedures and charts for inspection by variables for percentage nonconforming
ISO 5725	Precision of test methods - Determination of repeatability and reproducibility for a standard test method by inter-laboratory tests

3 Definitions

For the purpose of this European standard, the following definitions apply:

3.1 batch: A population of manufactured units from which a sample is to be taken for inspection and/or testing to determine conformance with acceptability criteria. A batch shall as far as is practicable consist of manufactured units of a single type, grade, size and composition, manufactured under essentially the same conditions at the same time.

NOTE : Sometimes referred to as a 'lot'.

3.2 sample: A sample consists of one or more manufactured units taken from a batch, these being selected at random without regard to their quality.

3.3 sample size: The number of units in a sample.

4 Guidance on sampling

4.1 Introduction

The basis of any inspection of manufactured units is to obtain sound information on their fitness for purpose (quality). Advanced technical ceramics are diverse in material, format and application, as are the methods devised to test their fitness for purposes. Before arranging any inspection or testing scheme it is wise to consider in depth the nature of the material, its final format in relation to the test specimens required, and the failure criticality in its application.

Many inspections and tests are carried out under controlled conditions of manufacture and assessment in laboratories, or in near-clinical conditions in which manufacturing variability is reduced to a minimum and is under strict control. Thus some form of sampling scheme is required in order to investigate the variability of the product, and to assess acceptability.

Occasionally when the inspection is for critical defects and this can be achieved by non-destructive means, all the units in a batch may be inspected. In most circumstances, however, depending on the type and cost of inspection and the cost of manufacture, the number of items inspected (the sample) may necessarily be a relatively small proportion of the batch. Whichever the circumstance, the rules for sampling, the number of items to be inspected or tested and the criteria of quality on which acceptance or rejection of a batch is to be based, should be by agreement between the parties involved. It is normally inadvisable to base acceptance inspection on occasional sampling or sampling by simple percentage, and a recognized statistically based sampling scheme should be used. Such schemes are based on the mathematical theory of probability and the hypothesis that the values of measured properties of units selected randomly, are distributed normally about the mean.

4.2 Sampling schemes

Sampling schemes are divided into those for inspection by attributes or by variables. Inspection by attributes consists of examining a sampled item and deciding whether it is good or defective. A decision on acceptance of a batch is made by counting the number of defective items in the batch sample. Surface texture, and the presence of cracks, for example may be treated in this manner. Sampling plans for inspection by attributes are given in ISO 2859 Part 1.

Inspection by variables involves the measurement of a property or properties using recognized test methods producing numerical values for each item in the sample. These values are used in calculations prescribed by the sampling plan, to decide acceptance or rejection of the batch. Typical of properties measured in this type of inspection are density and flexural strength. Schemes for inspection by variables are given in ISO 3951.

Alternatively, some properties may be used to inspect by attributes by treating the items in a sample as having a limiting property value attribute.

In either type of inspection it should be emphasized that the samples chosen have a random chance of selection and that the data provided also include the elements of test method variation. The latter is assumed to be reduced to a minimum by the standardization of methods of test but nevertheless is still present. Equally it should be noted that the sampling schemes do not guarantee that the test data are truly indicative of the quality of the sampled batch. They only indicate a probability and thus contain a level of risk that a batch accepted could be bad or one rejected good. The important point is that the level of risk is calculated and known. The degree of risk may not be the same for the manufacturer and user but decreases for the user with the degree of severity of inspection, either by increased sample size or by testing more than one attribute and/or property.

5 Aspects for consideration when selecting a sampling scheme

5.1 Design value

The design value of a tested attribute or variable should be clearly known, and the degree of permitted deviation from either a mean or limit should be stated.

Ideally this value should include all the know cumulative variations from the manufacturing, selection and testing processes.

5.2 Representative sample

5.2.1 Production consistency

In any multiple manufacturing process, samples for testing to provide engineering data should be taken at a time when production is known to be consistent from the process indications. Material from non-representative production will give unrepresentative samples.

5.2.2 Random selection

All sampling procedures assume a regular variation of measured values, based on the equal probability of selecting any one sample. This is only achieved by random selection. Tables of random numbers are available while some hand held computers can generate random numbers to assist in selection processes. The natural human bias of selecting a readily accessible sample should be avoided.

5.3 Test methods

5.3.1 Product application

The test data provided may be selected to simulate the product application. For example, a structural ceramic in use may be a loaded disc, in which case flexural bend data can give indicative survival values.

5.3.2 Test method variability

Comparative engineering data can be gained only from standardized tests. However, each test method has its own levels of precision and accuracy, which contribute to the variation associated with the test result, (see ISO 5725)

6 Guidance on the application of tests, test piece preparation and interpretation of data

All aspects of the preparation of advanced technical ceramics, including the method of preparation of raw materials, the method of shaping and firing and the finishing conditions, are important in determining the properties of a ceramic components. Test-pieces that are specially prepared for the purpose of determining materials properties may yield different test results from those that might be determined directly on components. In this respect, caution is advised in the interpretation of test piece property data.

For the majority of materials, bulk density can act as an indicator of other material properties. High bulk density, relative to a theoretical maximum density, generally implies low residual porosity, good strength and hardness, provided that the microstructure is uniform. Bulk density can be heterogenous in components, especially if fabricated by a die-pressing or an injection-moulding technique, and large internal defects may not greatly influence density but can have a marked effect on mechanical strength. Such factors as these should not be ignored in the assessment of materials and components.

Many ceramics, especially those prepared by hot-pressing, extrusion and slip-casting, can have anisotropic properties and it is of prime importance that careful consideration be given to the siting and orientation of test pieces taken from a component. In particular, it may be important to measure critical properties such as strength, thermal expansion and other mechanical and thermomechanical properties, in orientations relevant to the component shape and application in service.

The procedures used to cut test pieces from components and those used to prepare the surfaces of test pieces are of extreme importance in the measurement of some properties, for example flexural strength. In some standard methods of test, more than one level or quality of test piece preparation may be described and choice will depend on careful consideration of the type of material, the property to be measured and the use in service.

In acceptance testing the above considerations, together with the requirements for test piece preparation specified in the relevant test methods and the number of test pieces taken from a unit component should be the subject of agreement between the parties involved.