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Fine ceramics (advanced ceramics, advanced technical ceramics) — Characteristic of piezoelectric properties under high-load conditions —

Part 1: Resonant-antiresonant method under high-temperature conditions

Céramiques techniques (céramiques avancées, céramiques techniques avancées) — Caractéristique des propriétés piézoélectriques en conditions de charge élevée —

Partie 1: Méthode résonante-antirésonante à des températures élevées

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Foreword

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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).

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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 206, *Fine ceramics*.

A list of all parts in the ISO 21819 series can be found on the ISO website.

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.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Characteristic of piezoelectric properties under high-load conditions —

Part 1:
Resonant-antiresonant method under high-temperature conditions

1 Scope

This document specifies a method of measuring piezoelectric properties of piezoelectric fine ceramics and other piezoelectric devices under high-temperature conditions, where the electromechanical coupling coefficient is determined based on measurements of resonance/antiresonance frequencies using impedance analysers.

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 60584-1, *Thermocouples — Part 1: Reference tables*

IEC 60584-2, *Thermocouples — Part 2: Tolerances*

EN 50324-1, *Piezoelectric properties of ceramic materials and components — Part 1: Terms and definitions*

EN 50324-2, *Piezoelectric properties of ceramic materials and components — Part 2: Method of measurement — Low power*

EN 50324-3, *Piezoelectric properties of ceramic materials and components — Part 3: Method of measurement — High power*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 50324-1, EN 50324-2 and EN 50324-3 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
resonant-antiresonant method
method where the ratio of mutual conversion between electrical energy and mechanical energy is measured based on the resonance frequency and antiresonance frequency of piezoelectric fine ceramics and other piezoelectric devices

3.2
resonance frequency
f_r
lower of two frequencies at which admittance or impedance between electrodes of a transducer achieves zero phase in the vicinity of the target vibration mode

3.3
antiresonance frequency
f_a
higher of two frequencies at which admittance or impedance between electrodes of a transducer achieves zero phase in the vicinity of the target vibration mode

4 Symbols

$\Delta k(t)$	Rate of change of electromechanical coupling coefficient (%)
k_t	Electromechanical coupling coefficient after holding for t min after the test piece reaches the test temperature ± 2 °C
k_1	Electromechanical coupling coefficient after holding for 1 min after the test piece reaches the test temperature ± 2 °C

5 Principle

Under high-temperature conditions, the polarization within piezoelectric ceramics becomes unstable and there is thus a risk that the piezoelectric properties might deteriorate as time advances. In order to take both the high-temperature environment and elapsed time into consideration, the electromechanical coupling coefficient is measured in a high-temperature environment as a function of time from the time point where the high-temperature conditions are reached.

Note that other methods of measuring piezoelectric properties, such as electric field-induced strain and/or resonance vibration displacement, can also be considered. However, this document makes use of the measurement of the electromechanical coupling coefficient via the resonant-antiresonant method due to the ease of measurement.

6 Specimens

This measurement method is not limited to the measurement of materials, but can also be applied to all piezoelectrics and other piezoelectric devices that are intended to operate in a high-temperature environment.

7 Measurement equipment

7.1 General

This clause details the apparatus used for measurement. Figure 1 explains the configuration of the measurement apparatus.