INTERNATIONAL STANDARD

ISO 5712

First edition
2022-05

Fine ceramics (advanced ceramics, advanced technical ceramics) — Method for measuring the power generation characteristics of piezoelectric resonant devices for stand-alone power sources

Céramiques techniques — Méthode de mesurage des caractéristiques de production d'énergie électrique d'un dispositif résonnant piézoélectrique pour une source d'alimentation autonome

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Reference number
ISO 5712:2022(E)

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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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.

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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*.

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.

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Introduction

Economic development is supported by infrastructure such as roads and railroads; however, maintaining ageing infrastructure at a low cost is a problem. An effective monitoring system for maintaining the health of infrastructure at a low cost is necessary, therefore a stand-alone power source is required because of requirements such as installation location, number of items and period of use. In addition, in the internet of things (IoT), power is needed everywhere in order for everything to be connected to the internet, and from that perspective a stand-alone power source is expected.

A self-supporting power source is a technology that collects energy such as light, vibration and heat, converts it into electrical energy and uses it. Power supplies for small electronic devices include those for various mobile devices, lighting switches, automotive tire-pressure monitoring systems (TPMS) and wireless sensor networks (sensor power supplies) that monitor infrastructure and the environment. The use of such power supplies is expanding to active type tags used for recognition, such as radio frequency identifiers (RFIDs). Vibratory electrical conversion using vibrational energy is considered to be easy to use because of its high energy density after sunlight. Various power generation experiments have already been conducted and its practical application has been accelerated. There are methods that use piezoelectric devices and electromagnetic induction for vibration electric conversion, but methods using ceramic piezoelectric devices are prominent because of the output voltage, device size and degree of structural freedom. The vibrations used in power generation in daily life have a wide variety of frequencies, and it is difficult to set conditions for obtaining an appropriate amount of power generation with piezoelectric devices that are highly frequency-dependent. Piezoelectric device structures are also broadly divided into cantilever (beam), plate and double-supported beam shapes, and the sizes are diversified according to the purpose and application. It is also difficult to set conditions.

Currently, the measurement of power generation performance of piezoelectric devices for self-supporting power supplies is performed by an arbitrary method. What device structure (e.g. size, structure) will be used? What kind of vibration (e.g. frequency, additional mass, displacement) is applied to the piezoelectric body? What kind of circuit configuration (e.g. output voltage, current, conversion efficiency, measuring instrument) is standardized?

For this reason, this document was created for measuring the power generation characteristics of piezoelectric devices for self-supporting power supplies.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Method for measuring the power generation characteristics of piezoelectric resonant devices for stand-alone power sources

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1 Scope

This document specifies a method for measuring power generation characteristics to evaluate and determine the output power, mechanical quality factor, electromechanical coupling factor and output efficiency of piezoelectric resonant devices used for self-sustaining power sources.

This document defines vibration-based test methods and characteristic parameters in order to accurately and practically evaluate the performance of piezoelectric resonant devices.

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.

ISO 20507, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20507 and the following apply.

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

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

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

3.1
resonance frequency
frequency when output voltage reaches maximum

3.2
resonance peak width
difference in frequency between two points having a value of 1/√2 of the maximum output voltage in an output voltage wave form

4 Measurement principle

A piezoelectric resonant device is subjected to mechanical vibration and the accompanying electrical charge generated by the piezoelectric resonant device is measured by load resistance as an output voltage, from which power generation characteristics are determined. The principal factors affecting power generation characteristics are the mechanical quality factor (Q_m) and the electromechanical coupling coefficient (k^2) of the piezoelectric device.

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