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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for thermal property measurements of metalized ceramic substrates

Part 1: Evaluation of thermal resistance for use in power modules

National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for thermal property measurements of metalized ceramic substrates —

Part 1: Evaluation of thermal resistance for use in power modules

*Céramiques techniques — Méthode d'essai pour les mesures des
propriétés thermiques des substrats céramiques métallisés —*

*Partie 1: Évaluation de la résistance thermique pour utilisation dans
les modules d'alimentation*





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Foreword

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

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Introduction

Electrical energy is predicted to become an increasingly major modality of energy usage in the future, and power conversion technologies play a crucial role in its generation, transmission, storage and use. Against this backdrop, power modules that use semiconductor devices to provide high-efficiency conversion and control of electric power are becoming an extremely important technology. While silicon has long been used as the primary material for power semiconductor devices, wide bandgap semiconductors using SiC, GaN and other such materials as next-generation power semiconductors are drawing increasing expectations for their prospects of greater energy conservation, higher output and high-speed operation. Power modules using next-generation power semiconductors of this type are also anticipated to provide higher output and higher energy density, and likewise to capitalize on the characteristics of these materials for high-temperature operation (in the near future, junction temperatures are anticipated to reach 250 °C), thus heat-dissipating technologies are becoming more important than ever before.

In high-output power modules, an insulating substrate serving as an electrical insulator is one of the most important component materials. As power semiconductor devices increase in power output and energy density, the amount and density of heat dissipated by these devices are also increasing, creating a demand for higher thermal conductivity in substrate. For this reason, ceramics are generally used as insulating substrates because of their high thermal conductivity. In addition, to minimize interfacial thermal resistance between constituent materials, metallic conductor circuit layers are also joined to ceramic substrates at high temperature. Heat-dissipating structures of this nature are termed metallized ceramic substrates.

Techniques are available to measure the thermal conductivity of the individual materials comprising metallized ceramic substrates; however, there are no established methods to evaluate the thermal characteristics of metallized ceramic substrates per se, or the thermal characteristics of power semiconductor devices in mounted form, which are key issues in the design of power modules with a high heat-dissipating efficiency.

This document provides a technique for bonding a metallized ceramic substrate equipped with a heater chip to a cold plate and for using the amount of heat dissipated by the heater chip and the temperature differential between the heater chip and the cold plate to measure the thermal resistance of a system including a metallized ceramic substrate. Manufacturers of ceramic elements, modules and other such devices can use this standard to evaluate the heat-dissipating characteristics of metallized ceramic substrates under common conditions.

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