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**Fine ceramics - Methods of test for coatings - Determination of  
internal stress in ceramic coatings by application of the Stoney  
formula**

精细陶瓷 涂层试验方法 基于Stoney公式的陶瓷涂层内应力测定

**(English Translation)**

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## Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part 1: Structure and drafting rules for standardization documents" Drafting.

This document is modified to adopt ISO 19674:2017 "Fine ceramics (advanced ceramics, advanced technical ceramics) coating test methods based on "Determination of internal stress in ceramic coatings based on Stoney's formula".

Compared with ISO 19674:2017, this document has many structural adjustments. The structural number changes between the two documents are shown in the table below.

See Appendix A.

This document has many technical differences compared to ISO 19674:2017.

A list of these technical differences and their reasons is given in Appendix B.

The following editorial changes were made to this document.

--- In order to coordinate with the existing standards, the name of the standard is changed to "Test method for fine ceramic coatings - Ceramic coatings based on Stoney formula Determination of stress within the layer";

--- Part of Chapter 8 and Chapter 4 of ISO 19674:2017 has been incorporated into Chapter 1, and the calculation formula in 7.6 has been incorporated into Chapter 4.

Part of the content of 6.2 was incorporated into 6.1, the content of 7.4 was incorporated into 7.2, the content of "Note 1" in Chapter 4 was incorporated into 7.3, and the content of 7.7 was incorporated into Entered 7.4;

--- Deleted "Note 2" in Chapter 4, "Examples" in Chapter 5 and "Note 3" in 7.5 of ISO 19674:2017;

--- Added Appendix A (informative) This document compares the structure number with ISO 19674:2017;

--- Added Appendix B (informative) Technical differences between this document and ISO 19674:2017 and their causes;

--- Added Appendix D (informative) Calculation of internal stress of ceramic coating on the surface of actual components.

## Introduction

Coatings are increasingly used to improve the functional properties of materials and components. Coatings can not only protect the base material from exposure to Damage

caused by harsh environments such as high stress and corrosive chemical environments can also give the base material other properties, such as using thermal barrier coatings to adjust Adjust thermal conductivity, adjust friction coefficient using low friction coatings (such as diamond-like coatings), adjust optical reflectivity using coatings with controlled optical properties Emission rate, etc.

The type of coating to be used in the application process depends on the functional requirements of the mechanical components.

Important factors are the thermal expansion properties of the coating and the substrate during the deposition process and/or during the cooling process from the coating preparation temperature to room temperature.

Internal stress caused by mismatch.

This paper presents a simple test technique and its application, based on Stoney's formula, to analyze the stresses induced by coatings on samples with known mechanical properties.

Performance) bending deformation, determine the internal stress of the coating (also called residual stress).

Fine ceramic coating test method based on Determination of Internal Stress of Ceramic Coatings Based on Stoney Formula

## 1 Scope

This document describes a method for determining the internal stress of ceramic coatings. The method measures the stress of a strip or disk coated on one side with a ceramic coating.

The results of the change in the radius of curvature of the shaped sample are applied to the Stoney formula to calculate the internal stress of the ceramic coating.

This document is applicable to coating thickness less than 10% of substrate thickness, sample contour curvature is spherical, sample deformation is elastic deformation, substrate initial Determination of internal stress in ceramic coatings with a flat initial profile or known curvature.

## 2 Normative references

This document has no normative references.

## 3 Terms and definitions

There are no terms or definitions that require definition in this document.

#### 4.1 Overview

By measuring the change in bending of a strip or disk-shaped sample with known thickness, coated on only one side, and with linear elastic properties the internal stress of the ceramic coating is calculated by measuring the internal stress of the ceramic coating. Since the ceramic coating is usually deposited and prepared at high temperature, the internal stress of the coating measured at other temperatures is the superposition of its intrinsic stress and the thermal stress caused by the thermal expansion mismatch between the coating and the substrate.

4.2 The coating to substrate thickness ratio is less than 2% when the coating to substrate thickness ratio is less than 2% ( $h_f/h_s < 0.02$ ), it is necessary to accurately know the coating thickness, substrate thickness, and substrate Young's modulus and Poisson's ratio are substituted into the curvature radius ( $R_{exp}$ ) measured from the sample profile in Stoney's formula [1], and the internal stress of the coating is calculated using formula (1).

Force ( $\sigma_0$ ).

$\sigma_0 = -$

$\frac{1 - \nu_s}{h_s^2}$

$\frac{R_{exp}}{6}$

Where.

$h_f$  --- coating thickness, in micrometers ( $\mu\text{m}$ );

$h_s$  --- substrate thickness, in millimeters (mm);

$E_s$  --- Young's modulus of the matrix, in GPa;

$\nu_s$  --- Poisson's ratio of the matrix;

$R_{exp}$  --- the measured radius of curvature, in meters (m).

4.3 The coating to substrate thickness ratio is between 2% and 10% when the coating-to-substrate thickness ratio is between 2% and 10% ( $0.02 \leq h_f/h_s < 0.1$ ), it is necessary to know the Young's modulus and Poise of the coating material.