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**Testing methods for measuring thermal
cycle resistance and thermal shock
resistance for thermal barrier coatings**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Osaka Science & Technology Center (OSTEC)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS H 8451:2008**), which has been technically revised.

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Testing methods for measuring thermal cycle resistance and thermal shock resistance for thermal barrier coatings

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 14188** : 2012, Edition 1, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the testing methods for measuring thermal cycle resistance and thermal shock resistance of thermal barrier coatings mainly used for hot parts in gas turbines to evaluate the durability thereof, which are coated on the substrate by thermal spraying.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 14188 : 2012 *Metallic and other inorganic coatings — Test methods for measuring thermal cycle resistance and thermal shock resistance for thermal barrier coatings* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7507 *Vernier, dial and digital callipers*

JIS H 8402 *Test methods of tensile adhesive strength for thermal-sprayed coatings*

JIS Z 8401 *Rounding of numbers*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions apply.

3.1

thermal barrier coatings (TBC)

two-layer coating in which a bond coat performed on the surface of substrate and a top

coat in which ceramics having high melting point and low heat conductivity is used, to suppress the temperature rise of substrate composing hot parts due to combustion gas

When a TBC is exposed to operating at a high temperature, thermally grown oxide (see 3.2) develops between top coat and bond coat, and the TBC becomes three-layer coating (see Figure 1).

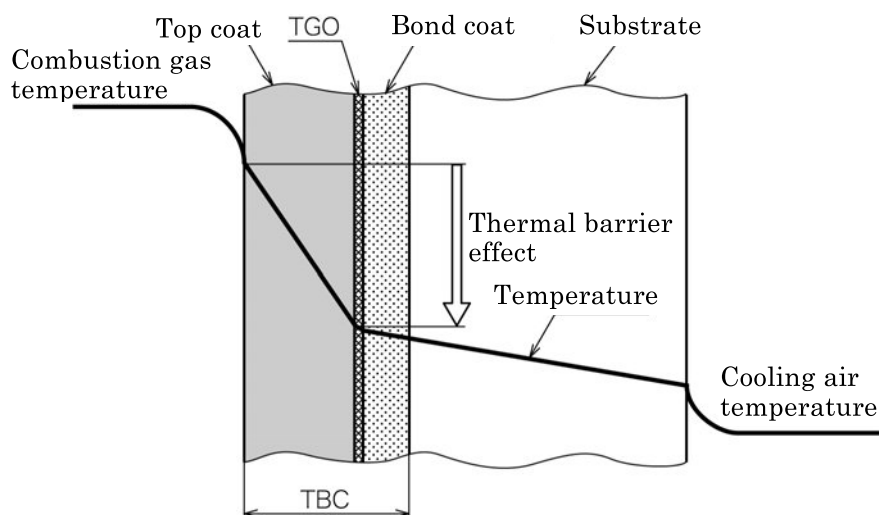


Figure 1 Diagrammatic view of section and effects of TBC

3.2

thermally grown oxide (TGO)

oxide generated between top coat and bond coat when the TBC is heated (see Figure 1)

3.3

ratio of spalling areas

proportion of the total spalling area relative to the effective area of the TBC

3.4

critical number of cycles to spalling

number of thermal cycles when the ratio of spalling areas achieves 30 % in the thermal cycle resistance test (see Figure 6)

3.5

mean critical number of cycles to spalling

mean value of the critical number of cycles to spalling

3.6

thermal shock temperature difference (ΔT)

difference in temperatures between heating and cooling water treatments of the test

pieces in thermal shock resistance tests

3.7

thermal shock resistance (ΔT_r)

thermal shock temperature difference that causes 30 % reduction of the tensile adhesive strength due to the thermal shock relative to the tensile adhesive strength in the absence of thermal shock (see Figure 10)

4 Classification of test methods

The test methods of the resistance of TBC shall be in accordance with **a)** and/or **b)** of the following.

- a) Thermal cycle resistance test
- b) Thermal shock resistance test

5 Thermal cycle resistance test

5.1 General

The thermal cycle resistance test is carried out using steady cyclical heating and cooling procedures to measure the ratio of spalling areas of TBC [1].

NOTE This method is useful in the selection of materials, coating processes and process conditions of top coat and bond coat in the TBC system used in gas turbines operating at elevated temperatures under general usage condition.

5.2 Apparatus

The apparatus consists of a heating/cooling device and temperature control system. A typical basic construction of apparatus for thermal cycle resistance test is shown in Figure 2.