

ICS 25.220.20

CCS A 29



**NATIONAL STANDARD OF THE  
PEOPLE'S REPUBLIC OF CHINA**

**GB/T 46601-2025**

---

**Thermal spraying - Evaluation of adhesion/cohesion of thermal  
sprayed ceramic coatings by transverse scratch testing**

热喷涂 采用横向划痕试验评估热喷涂陶瓷涂层的结合力和内聚力

**(English Translation)**

**Issued on: October 31, 2025**

**Implemented on: May 1, 2026**

---

**Issued by: State Administration for Market Regulation**

## Table of Contents

|                                                                                  |  |
|----------------------------------------------------------------------------------|--|
| Preface                                                                          |  |
| Introduction                                                                     |  |
| 1 Scope                                                                          |  |
| 2 Normative References                                                           |  |
| 3 Terms and Definitions                                                          |  |
| 4 Principle                                                                      |  |
| 5 Equipment                                                                      |  |
| 6 Transverse scratch test procedure                                              |  |
| 6.1 Basic Requirements for Test Specimens                                        |  |
| 6.2 Environmental Conditions                                                     |  |
| 6.3 Scratch test on cross section                                                |  |
| 6.4 Damage Mode Analysis                                                         |  |
| 7 Scratch Test Report                                                            |  |
| Appendix A (Informative) Typical Failure Modes of Coatings After Scratch Testing |  |
| Appendix B (Informative) Transverse Scratch Test Records                         |  |
| References                                                                       |  |

## Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part 1: Structure and Drafting Rules of Standardization Documents".

Drafting.

This document modifies and adopts ISO 27307:2015 "Thermal spraying - Evaluation of adhesion and internal strength of thermally sprayed ceramic coatings by transverse scratch test".

"Gathering Strength" the technical differences between this document and ISO 27307:2015, and the reasons therefor, are as follows.

---The equipment calibration requirements have been changed (see Chapter 5) to suit my country's technical conditions;

---The nature of Appendix B has been changed from normative to informative to suit my country's technical conditions;

---Chapter 7 adds a "Test Results" section to increase the operability of the standard.

The following editorial changes have been made to this document.

---A caption for Figure A.1 has been added (see Appendix A);

---A preface to Table B.1 has been added (see Appendix B);

Appendix C (informative) has been deleted.

Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents.

This document was proposed by the China Machinery Industry Federation.

This document is under the jurisdiction of the National Technical Committee on Standardization of Metallic and Non-metallic Coatings (SAC/TC57).

## Introduction

Thermal spray ceramic coatings have been widely used to modify the surface properties of metal parts. Thermal spray ceramic coatings can prevent various types of...

Thermal spraying of ceramics avoids wear, corrosion, and thermal damage, thus extending the service life of components, reducing maintenance frequency, and lowering maintenance costs.

The microstructure characteristics of the coating are described by the morphology of deformed particles, the size and density of pores, interlayer/intralayer thermal cracks, and inclusions.

Although in some cases it is intentional to include cracks in the microstructure of thermally sprayed ceramic coatings (such as to improve the thermal insulation performance of thermal barrier coatings), (Although the microstructure may contain cracks), the weak bonding between the layers and the incomplete structure due to pores or thermal cracks make this type of coating incomplete.

The mechanical properties of thermally sprayed ceramic coatings are far lower than those of the corresponding bulk materials. Clearly, the service life and functionality of the coating largely depend on the adhesion between the coating and the substrate, as well as the cohesive force between the layers, are crucial properties of thermal spray coatings. Therefore, adhesion and cohesive force are the most important properties of thermal spray coatings.

One of the reasons is that it needs to be systematically evaluated.

This document provides guidelines for conducting transverse scratch tests, which can be used to determine the adhesion and cohesion of the coating.

Thermal spraying was evaluated using a transverse scratch test.

The bonding and cohesive strength of ceramic coatings

## 1 Scope

This document specifies a method for evaluating the adhesion and cohesion of thermally sprayed ceramic coating-substrate systems using a transverse scratch test.

This document applies to thermally sprayed ceramic coatings with a thickness greater than 50 µm, and also to coatings applied using other spraying processes, such as cold spraying and aerosol spraying.

Ceramic coatings prepared by deposition, etc.

## 2 Normative references

The contents of the following documents, through normative references within the text, constitute essential provisions of this document. Dated citations are not included.

For references to documents, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies.

This document.

ISO 20502 Fine ceramics (advanced ceramics, advanced technical ceramics) - Determination of the adhesion of ceramic coatings by scratch test [Finace-Note. GB/T 30707-2014 Test method for adhesion of fine ceramic coatings - Scratch test (ISO 20502:2005, MOD)]

## 3 Terms and Definitions

The following terms and definitions apply to this document.

Adhesion

The coating and the substrate are bonded together by atomic valence forces and/or mechanical bonding forces to form interfacial forces.

cohesion

The adhesive force between the structural components of the coating.

## 4 Principles

Scratch testing involves sliding an indenter across a coating-substrate system. The indenter's material, dimensions, and geometry are known, such as a Rockwell conical gold indenter.

Diamond indenter. Tests are conducted over a given length with a constant load; if the

coating peels off from the substrate, the coating-substrate relationship can be evaluated.

The system's adhesion strength can also be assessed by comparing it with similar coating-substrate composite systems to determine its level of adhesion. If the failure only occurs...

Within thermally sprayed ceramic coatings, the test assesses the cohesive strength of the coating itself. If no damage occurs, the test load should be increased until...

The coating is damaged. Appendix A lists various coating failure modes that may occur during scratch testing.

During the scratch test, the tensile stress generated as the indenter slides over the coating can cause the coating to crack; these stresses can balance the preceding compressive friction.

Stress. An acoustic emission (AE) sensor mounted on the indenter bracket of the scratch testing machine can detect the occurrence of fracture. Furthermore, the indenter and the measuring...

The tangential force between the indenter and the specimen is used to provide more information about the failure condition. This tangential force  $F_g$  (often mistakenly referred to as friction) is generated between the indenter and the specimen.

It consists of frictional force and plowing force that deforms the coating-substrate system.