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GB/T 5028-2025

Replacing GB/T 5028-2008

Metallic materials - Sheet and strip - Determination of tensile strain hardening exponent (n)

金属材料 薄板和薄带 拉伸应变硬化指数(n 值)的测定

(ISO 10275:2020, Metallic materials - Sheet and strip - Determination of tensile strain hardening exponent, MOD)

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Foreword

This document was drafted in accordance with the rules given in GB/T 1.1-2020, *Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents*.

This document replaces GB/T 5028-2008, *Metallic materials - Sheet and strip - Determination of tensile strain hardening exponent*. Compared with GB/T 5028-2008, in addition to structural adjustments and editorial changes, the main technical Contents changes of this document are as follows:

-- Change the symbol of true stress from "s" to "σ", and the symbol of true plastic strain from "e" to "ε_p" (see Chapter 4; Chapter 3 of the 2008 edition);

-- Add “Unless otherwise agreed, the method to be used is at the discretion of the material manufacturer or the laboratory designated by it” (see 8.5; 7.5 of the 2008 edition);

-- Change the test report by revising item g) to “test results (if necessary, the strength coefficient C value should be provided)” (see Chapter 9; Chapter 8 of the 2008 edition).

This document adopts ISO 10275:2020 *Metallic materials - Sheet and strip - Determination of tensile strain hardening exponent* by modification.

The technical differences between this document and ISO 10275:2020 and their reasons are as follows:

-- Use the normative reference GB/T 228.1 to replace ISO 6892-1 (see 6.1, 6.3, 7.1, 8.2, 8.3) to conform to national conditions and facilitate use;

-- Use the normative reference GB/T 5027 to replace ISO 10113 (see 6.2, 7.2) to conform to national conditions and facilitate use;

-- Change the content of 8.5 to adapt to the characteristics of different materials. It is suggested that the material manufacturer or the laboratory designated by the material manufacturer decide whether to deduct the elastic strain when calculating n. Specify Method A: Calculate the true plastic strain using Formula (4). Add Method B: Approximate the true plastic strain using Formula (6), to conform to national conditions and facilitate use;

-- Add reference to GB/T 8170 for numerical rounding (see 8.8) to conform to national conditions and facilitate use;

-- Change item g) of Chapter 9 to “test results (if necessary, the strength coefficient C value should be provided)” to indicate the importance of the strength coefficient.

Metallic materials - Sheet and strip - Determination of tensile strain hardening exponent (n)

1 Scope

This document specifies the principle, test apparatus, test samples, test procedures and test report for determining the tensile strain hardening exponent (n value) of metal sheet and strip.

This method is only applicable to the part of the stress-strain curve that shows a monotonically continuous increase within the plastic deformation range (see 8.4).

If the stress-strain curve of the material during the work hardening stage is saw-toothed (such as the Portevin-Le Chatelier saw-tooth yield effect exhibited by some AlMg alloys), in order to make the given results have a certain degree of repeatability, an automatic measurement method is used (linear regression of the logarithm of the true stress-true plastic strain, see 8.7).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 228.1, Metallic materials - Tensile testing - Part 1: Method of test at room temperature (GB/T 228.1-2021, ISO 6892-1:2019, MOD)

GB/T 5027, Metallic materials - Sheet and strip - Determination of plastic strain ratio (r) (GB/T 5027-2025, ISO 10113:2020, MOD)

GB/T 8170, Rules of rounding off for numerical values & expression and judgment of limiting values

GB/T 12160, Metallic materials - Calibration of extensometers systems used in uniaxial testing (GB/T 12160-2019, ISO 9513:2012, IDT)

GB/T 16825.1, Metallic materials - Calibration and verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system (GB/T 16825.1-2022, ISO 7500-1:2018, IDT)

3 Terms and definitions

No terms and definitions need to be defined in this document.

4 Symbols and their meanings

4.1 The symbols used in this document and their meanings are shown in Table 1.

4.2 Tensile strain hardening exponent (n) is defined as the true plastic strain exponent in the mathematical equation of true stress and true plastic strain under uniaxial tensile stress. This equation can be expressed by Formula (1):

$$\sigma = C \times \varepsilon_p{}^n \qquad \cdots\cdots (1)$$

4.3 The equation shown in Formula (1) can be transformed into the logarithmic equation shown in Formula (2):

$$\ln\sigma = \ln C + n\ln\varepsilon_p \qquad \cdots\cdots(2)$$

The slope of the straight line in the log-log coordinate plane is the tensile strain hardening exponent.

5 Principle

The sample is subjected to axial tensile deformation at a specified constant rate within the range of uniform plastic deformation. Calculate the tensile strain hardening exponent (n) using the stress-strain curve over the entire range of uniform plastic deformation, or using a portion of the stress-strain curve over the range of uniform plastic deformation.

6 Test apparatus

6.1 The tensile testing machine shall be verified and calibrated to an accuracy of Class 1 or better in accordance with GB/T 1825.1. The sample clamping method shall comply with the provisions of GB/T 228.1.

6.2 The accuracy of the extensometer used to measure gauge length change shall meet the requirements of Grade 2 or better in GB/T 12160 (if the r value of the material is also determined in accordance with GB/T 5027, an extensometer of Grade 1 or better shall be used).

6.3 The dimension measuring device shall be capable of measuring the thickness and width of the parallel length portion of the sample. The measurement error shall comply with the provisions of GB/T 228.1.

7 Test sample

7.1 Sampling shall be carried out in accordance with the requirements of the relevant product standards. If the product standards do not specify, sampling shall be carried out in accordance with the agreement between the relevant parties. The size tolerance, shape tolerance and marking of the sample shall comply with the provisions of GB/T 228.1.

7.2 If the plastic strain ratio (r) is to be determined at the same time as the tensile strain hardening exponent (n), the sample shall also comply with the requirements of GB/T 5027.

7.3 Unless otherwise specified, the thickness of the test sample shall be the original thickness of the product.

7.4 The surface of the sample shall not have any defects such as scratches.

8 Test procedure

8.1 The test is generally carried out at room temperature between 10 °C and 35 °C. If the test is required to be carried out under temperature-controlled conditions, the temperature shall be controlled at 23 ℃ ± 5 ℃.

8.2 The sample shall be clamped on the tensile testing machine (see 6.1) and the axial load on the sample shall be ensured to comply with the requirements of GB/T 228.1.

8.3 Unless otherwise specified, during the plastic deformation stage, the strain rate in the parallel length portion of the sample shall not exceed 0.008 s^{-1}. This rate shall be kept constant during the determination of the tensile strain hardening exponent (n).

If it is necessary to determine the specified plastic elongation strength, yield strength and other properties at the same time as determining the tensile strain hardening exponent (n), the test rate shall also meet the relevant requirements of GB/T 228.1.

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