



Standard Test Method for Tensile Strain-Hardening Exponents (n -Values) of Metallic Sheet Materials¹

This standard is issued under the fixed designation E646; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

This test method for determining tensile strain-hardening exponents n utilizes stress-strain data obtained in a uniaxial tension test. Tensile data are obtained in a continuous and rate-controlled manner via displacement or strain control. The strain-hardening exponents are determined from an empirical representation over the range of interest of the true-stress versus true-strain curve. The mathematical representation used in this method is a power curve (**Note 1**) of the form **(1)**²:

$$\sigma = K\epsilon^n$$

where:

σ = true stress,

ϵ = plastic component of true strain, but in special cases may be the total true strain. (See **10.2**),

K = is a constant, often called the strength coefficient having the units of stress, and

n = strain-hardening exponent

1. Scope*

1.1 This test method covers the determination of a strain-hardening exponent by tension testing of metallic sheet materials for which plastic-flow behavior obeys the power curve given in the Introduction.

NOTE 1—A single power curve may not be a satisfactory fit to the entire stress-strain curve between yield and necking. If such is the case, more than one value of the strain-hardening exponent may be obtained **(2)** by agreement using this test method.

1.2 This test method is specifically for metallic sheet materials with thicknesses of at least 0.005 in. (0.13 mm) but not greater than 0.25 in. (6.4 mm). The method has successfully been and may be applied to other forms and thicknesses by agreement

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

NOTE 2—The value of the strain-hardening exponent, n , has no units and is independent of the units used in its determination

¹ This test method is under the jurisdiction of ASTM Committee E28 on Mechanical Testing and is the direct responsibility of Subcommittee E28.02 on Ductility and Formability.

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² The boldface numbers in parentheses refer to the list of references appended to this method.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:³

- E4 Practices for Force Verification of Testing Machines
 - E6 Terminology Relating to Methods of Mechanical Testing
 - E8/E8M Test Methods for Tension Testing of Metallic Materials
 - E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
 - E83 Practice for Verification and Classification of Extensometer Systems
 - E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus
 - E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
 - E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- ### 2.2 ISO Standard
- ISO 10275:2007 Metallic materials -- Sheet and strip -- Determination of tensile strain hardening exponent

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard