



Designation: D 5938 – 96

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM

Standard Guide Describing the General Principles for Determination of Tensile Properties of Plastics¹

This standard is issued under the fixed designation D 5938; 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.

1. Scope

1.1 This guide specifies the general principles for determining the tensile properties of plastics under defined conditions.

1.2 Several different types of test specimen are defined to suit different types of material that are detailed in other standards.

1.3 This guide is used to investigate the tensile behaviour of the test specimens and for determining the tensile strength, tensile modulus and other aspects of the tensile stress/strain relationship under the conditions defined.

1.4 This guide is selectively suitable for use with the following range of materials:

1.4.1 Rigid and semirigid thermoplastics moulding and extrusion materials, including filled and reinforced compounds in addition to unfilled types, rigid and semirigid thermoplastics sheets and films,

1.4.2 Rigid and semirigid thermosetting moulding materials, including filled and reinforced compounds, rigid and semirigid thermosetting sheets, including laminates,

1.4.3 Fibre-reinforced thermoset and thermoplastics composites incorporating unidirectional or nonunidirectional reinforcements such as mat, woven fabrics, woven rovings, chopped strands, combination and hybrid reinforcements, rovings and milled fibres, sheets made from pre-impregnated materials (prepregs), and

1.4.4 Thermotropic liquid crystal polymers.

1.5 This guide is not suitable normally for use with rigid cellular materials or sandwich structures containing cellular material.

1.6 This guide is applied using specimens that may be either moulded to the chosen dimensions or machined, cut, or punched from finished and semifinished products such as mouldings, laminates, films, and extruded or cast sheet. In some cases, a multipurpose test specimen (see ISO 3167:1993 (Specification D 5936)), may be used.

1.7 This guide specifies preferred dimensions for the test specimens. Tests that are carried out on specimens of different dimensions, or on specimens that are prepared under different conditions, may produce results that are not comparable. Other

factors, such as the speed of testing and the conditioning of the specimens, also can influence the results. Consequently, when comparative data are required, these factors must be carefully controlled and recorded.

1.8 This guide is identical to ISO 527-1. This standard is comparable to Test Method D 638 but neither standard should be substituted for the other. The two standards may differ with respect to test specimen dimensions, test specimen conditioning, test equipment, testing conditions, etc. The two methods may not give the same results.

1.9 *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:

D 638 Test Method for Tensile Properties of Plastics²

D 5936 Specification for Multipurpose Test Specimens Used for Testing Plastics³

2.2 ISO Standards:⁴

ISO 291:1977 Plastics—Standard Atmospheres for Conditioning and Testing

ISO 527-1 Determination of Tensile Properties—Part 1: General Principles

ISO 2602:1980 Statistical Interpretation of Test Results—Estimation of the Mean—Confidence Interval

ISO 5893:1985 Rubber and Plastics Test Equipment—Tensile, Flexural and Compression Types (Constant Rate of Traverse)—Description

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *gage length, L_0 , n* —initial distance between the gage marks on the central part of the test specimen. See figures of the test specimens in the relevant part of ISO 527. It is expressed in millimetres (mm).

3.2 *modulus of elasticity in tension, Young's modulus,*

¹ This guide is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.61 on U.S. Technical Advisory Group for ISO/TC 61 on Plastics.

Current edition approved June 10, 1996. Published August 1996.

² Annual Book of ASTM Standards, Vol 08.01.

³ Annual Book of ASTM Standards, Vol 08.03.

⁴ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

E_t —ratio of the stress difference σ_2 minus σ_1 to the corresponding strain difference values $\epsilon_2 = 0.0025$ minus $\epsilon_1 = 0.0005$ (see Fig. 1, curve d and 11.3, Eq 8). It is expressed in megapascals, (MPa). This definition does not apply to films and rubber.

3.2.1 *Discussion*—With computer-aided equipment, the determination of the modulus E_t using two distinct stress/strain points can be replaced by a linear regression procedure applied on the part of the curve between these mentioned points.

3.3 *nominal tensile strain, ϵ , n* —increase in length per unit original length of the distance between grips (grip separation). It is expressed as a dimensionless ratio or in percentage (%) (see 11.2, Eq 6 and Eq 7).

3.3.1 It is used for strains beyond yield point (see 3.8.3). For strains up to yield point, see 3.7. It represents the total relative elongation that takes place along the free length of the test specimen.

3.3.1.1 *nominal tensile strain at break, ϵ_{tB} , n* —nominal

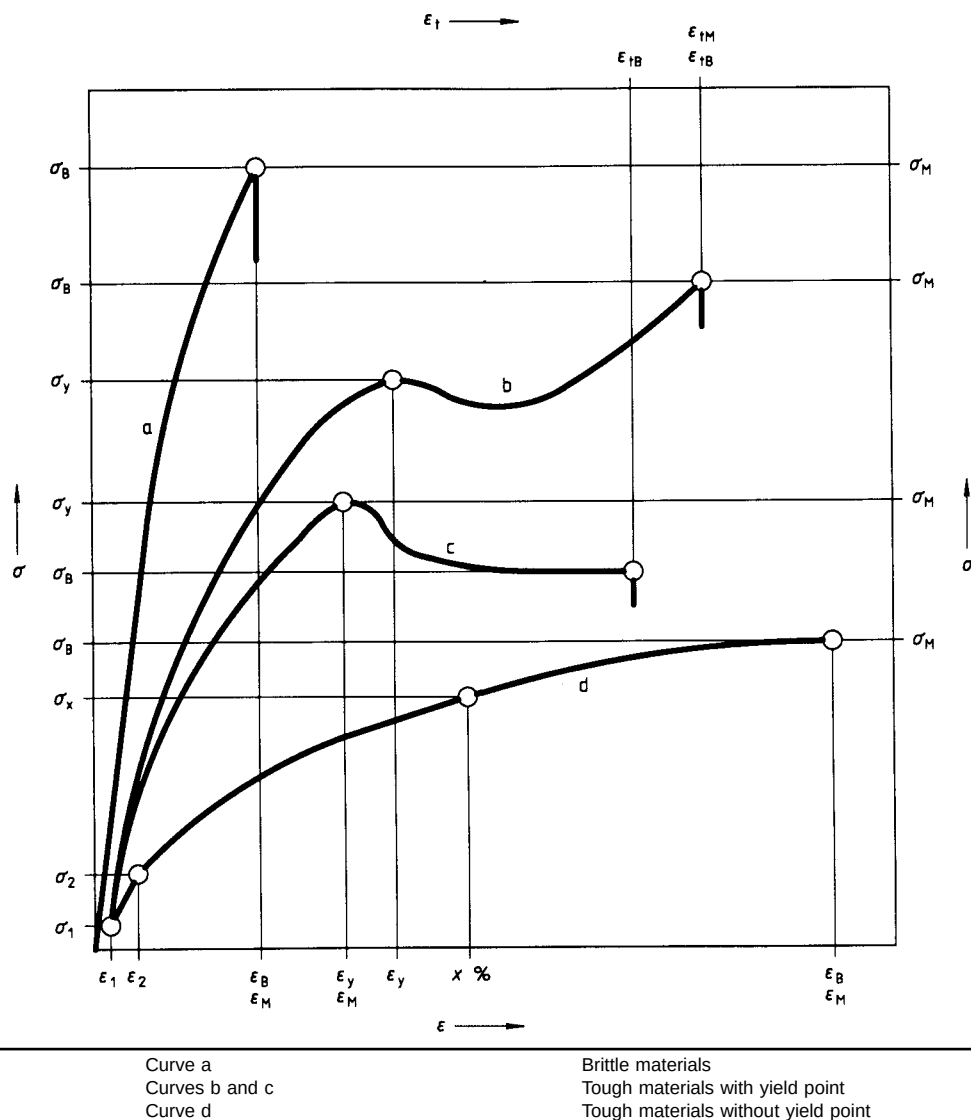
tensile strain at the tensile stress at break (see 3.8.2), if the specimen breaks after yielding (see Fig. 1, curves b and c). It is expressed as a dimensionless ratio, or in percentage (%). For breaking without yielding, see 3.7.3.

3.4 *nominal tensile strain at tensile strength, ϵ_{tM} , n* —nominal tensile strain at tensile strength (see 3.8.1), if this occurs after yielding (see Fig. 1, curve b). It is expressed as a dimensionless ratio or in percentage (%). For strength values without or at yielding, see 3.7.2.

3.5 *speed of testing, v* —rate of separation of the grips of the testing machine during the test. It is expressed in millimetres per minute (mm/min).

3.6 *Poisson's ratio, μ , n* —negative ratio of the tensile strain ϵ_n , in one of the two axes normal to the direction of pull, to the corresponding strain ϵ in the direction of pull, within the initial linear portion of the longitudinal versus normal strain curve. It is expressed as a dimensionless ratio.

3.6.1 Poisson's ratio is indicated as μ_p (width direction) or



The points for the calculation of Young's modulus E_t according to 11.3 are indicated by (σ_1, ϵ_1) and (σ_2, ϵ_2) , shown only for Curve d ($\epsilon_1 = 0.0005$, $\epsilon_2 = 0.0025$).

FIG. 1 Typical Stress/Strain Curves