Physical Properties Testing Technical Bulletin

MANUFACTURER

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TENSILE TESTING OF PLASTICS

ASTM D638, ISO 527

Scope:

Tensile tests measure the force required to break a specimen and the extent to which the specimen stretches or elongates to that breaking point. Tensile tests produce a stress-strain diagram, which is used to determine tensile modulus. The data is often used to specify a material, to design parts to withstand application force and as a quality control check of materials. Since the physical properties of many materials (especially thermoplastics) can vary depending on ambient temperature, it is sometimes appropriate to test materials at temperatures that simulate the intended end use environment.

Test Procedure:

Specimens are placed in the grips of the Instron at a specified grip separation and pulled until failure. For ASTM D638 the test speed is determined by the material specification. For ISO 527 the test speed is typically 5 or 50mm/min for measuring strength and elongation and 1mm/min for measuring modulus. An extensometer is used to determine elongation and tensile modulus.

Elevated or Reduced Temperature Test Procedure:

A thermal chamber is installed on the Instron universal test machine. The chamber is designed to allow the test mounts from the base and crosshead of the Instron to pass through the top and bottom of the chamber. Standard test fixtures are installed inside the chamber, and testing is conducted inside the controlled thermal environment the same as it would be at ambient temperature. The chamber has internal electric heaters for elevated temperatures and uses external carbon dioxide gas as a coolant for reduced temperatures. The size of the chamber places a limitation on the maximum elongation that can be reached, and extensometer are generally limited to no more than 200° C.

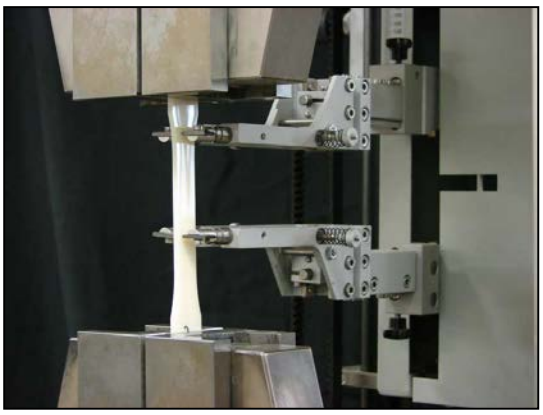
Specimen size:

The most common specimen for ASTM D638 is a Type I tensile bar. The most common specimen for ISO 527 is the ISO 3167 Type 1A multipurpose specimen. ASTM D882 uses strips cut from thin sheet or film.

Data:

The following calculations can be made from tensile test results:

- Tensile strength (at yield and at break)
- Tensile modulus
- Strain
- Elongation and percent elongation at yield and at break



Equipment Used:

Instron Universal Tester

Extensometers

COMPRESSIVE PROPERTIES

ASTM D695, ISO 60

Scope:

Compressive properties describe the behavior of a material when it is subjected to a compressive load. Loading is at a relatively low and uniform rate. Compressive strength and modulus are the two most common values produced.

Test Procedure:

The specimen is placed between compressive plates parallel to the surface. The specimen is then compressed at a uniform rate. The maximum load is recorded along with stress-strain data. An extensometer attached to the front of the fixture is used to determine modulus.

Specimen size:

Specimens can either be blocks or cylinders. For ASTM, the typical blocks are 12.7 x 12.7 x 25.4mm (½ by ½ by 1 in). and the cylinders are 12.7mm (½ in) in diameter and 25.4mm (1 in) long. For ISO, the preferred specimens are 50 x 10 x 4mm for modulus and 10 x 10 x 4mm for strength.

Data:

Compressive strength and modulus are two useful calculations.

Compressive strength =

maximum compressive load

minimum cross-sectional area

Compressive modulus =

change in stress

change in strain

Equipment Used:

Instron Universal Tester

Compression fixture

Extensometer

FLEXURAL PROPERTIES

ASTM D790, ISO 178

Scope:

The flexural test measures the force required to bend a beam under three point loading conditions. The data is often used to select materials for parts that will support loads without flexing. Flexural modulus is used as an indication of a material's stiffness when flexed. Since the physical properties of many materials (especially thermoplastics) can vary depending on ambient temperature, it is sometimes appropriate to test materials at temperatures that simulate the intended end use environment.

Test Procedure:

Most commonly the specimen lies on a support span and the load is applied to the center by the loading nose producing three point bending at a specified rate. The parameters for this test are the support span, the speed of the loading, and the maximum deflection for the test. These parameters are based on the test specimen thickness and are defined differently by ASTM and ISO. For ASTM D790, the test is stopped when the specimen reaches 5% deflection or the specimen breaks before 5%. For ISO 178, the test is stopped when the specimen breaks. Of the specimen does not break, the test is continued as far a possible and the stress at 3.5% (conventional deflection) is reported.

Elevated or Reduced Temperature Test Procedure:

A thermal chamber is installed on the universal test machine. The chamber is designed to allow the test mounts from the base and crosshead of the universal tester to pass through the top and bottom of the chamber. Standard test fixtures are installed inside the chamber, and testing is conducted inside the controlled thermal environment the same as it would be at ambient temperature. The chamber has internal electric heaters for elevated temperatures and uses external carbon dioxide gas as a coolant for reduced temperatures.

Specimen size:

A variety of specimen shapes can be used for this test, but the most commonly used specimen size for ASTM is 3.2mm x 12.7mm x 125mm (0.125" x 0.5" x 5.0") and for ISO is 10mm x 4mm x 80mm.

Data:

Flexural stress at yield, flexural strain at yield, flexural stress at break, flexural strain at break, flexural stress at 3.5% (ISO) or 5.0% (ASTM) deflection, flexural modulus (the ratio of stress to strain in flexural deformation). Stress/Strain curves and raw data can be provided.

Equipment Used:

Universal Tester

Flexural test fixtures

DUROMETER HARDNESS SHORE HARDNESS

ASTM D2240

Scope:

Durometer Hardness is used to determine the relative hardness of soft materials, usually plastic or rubber. The test measures the penetration of a specified indentor into the material under specified conditions of force and time. The hardness value is often used to identify or specify a particular hardness of elastomers or as a quality control measure on lots of material.

Test Procedure:

The specimen is first placed on a hard flat surface. The indentor for the instrument is then pressed into the specimen making sure that it is parallel to the surface. The hardness is read within one second (or as specified by the customer) of firm contact with the specimen.

Specimen size:

The test specimens are generally 6.4mm (¼ in) thick. It is possible to pile several specimens to achieve the 6.4mm thickness, but one specimen is preferred.

Data:

The hardness numbers are derived from a scale. Shore A and Shore D hardness scales are common, with the A scale being used for softer and the D scale being used for harder materials.

Equipment Used:

Durometer Hardness Tester

Taber Abrasion

ASTM D1044 (Haze), D3389, D4060 (Weight Loss)

Scope:

Taber abrasion is a test to determine a plastic's resistance to abrasion. Resistance to abrasion is defined as the ability of a material to withstand mechanical action such as rubbing, scraping, or erosion. Abrasion can be difficult to compare but haze variation or weight loss are often evaluated.

Test Procedure:

The haze or original weight of test specimen is measured. The test specimen is then placed on the abrasion tester. A 250, 500, or 1000-gram load is placed on top of the abrader wheel and allowed to spin for a specified number of revolutions. Different abrading wheels are specified. A haze measurement or final weight is taken. The load and wheel can be adjusted for softer and harder materials.

Specimen size:

Either a 4-inch diameter disk or a 4 sq. inch plate is used. A ¼ inch diameter whole in center is required.

Data:

Results are expressed by changes in % haze or in weight loss in mg/# of cycles.

Equipment Used:

Taber Abrasion Apparatus

Abrasion Wheels

Haze meter

Balance