

ASTM D638 Tensile Properties of Plastics

TEST METHOD SUMMARY

Tensile testing of plastics per ASTM D638 is a widely used and extremely important test method. By simply measuring the force required to pull a test specimen to its breaking point, several material properties can be determined. This data enables both product design engineers and quality managers to accurately predict the performance of their products in end-use applications. This information is critical for developing new products, ensuring compliance to industry or government standards, improving manufacturing and reducing production costs.

Sometimes referred to as pull testing, these tests require “dumbbell” or “dogbone” shaped test specimens to be placed in the grips of a universal testing machine and subjected to controlled tension until they fail. Test speed is determined by the material specification and an extensometer is used to measure specimen parameters. The resulting tensile test data reveals essential material properties such as ultimate tensile strength, yield strength, elongation and reduction in area. This information also allows calculations of Young’s modulus and Poisson’s ratio. ASTM D638 is very similar to ISO 527-2, with one key exception being analysis of the non-linear portion of a material’s stress-strain curve. For materials which have little or no linear region, the variation between ASTM and ISO can be significant. Due to the viscoelastic nature of plastics, these tests are often performed with temperature chambers to simulate end-use environments.

Solutions for ASTM D638 typically include these types of components;

LOAD FRAME OPTIONS*

Both the premium MTS Criterion® and the economical MTS Exceed® universal testing machines are ideal for tensile testing of plastics per ASTM D638. These test systems come in a variety of force capacities and frame styles, ranging from 1-column tabletops to larger 2-column floor-standing models. The 30kN and 100kN models also have dual-zone test spaces to reduce set-up times if you frequently change test requirements. And as an alternative to a new load frame, you can modernize the software and controls of your old test system with an MTS ReNew™ Upgrade.



MTS Criterion®
Electromechanical Universal Test Systems






MTS Exceed®
Electromechanical Universal Test Systems

GRIP OPTIONS*

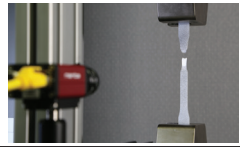

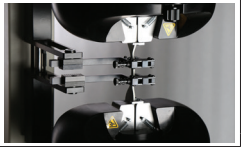
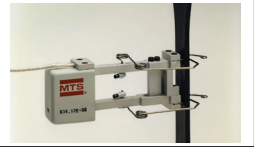
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|--|--|---|--|
| Pneumatic Vise Grips | Manual Wedge Grips | Screw Action Grips | Manual Vise Grips |
| <ul style="list-style-type: none"> » Most commonly used to reduce test set-up time » Many different faces and larger specimen opening for universal testing needs » Fast and easy operation » Low effort grips | <ul style="list-style-type: none"> » Excellent for thick rigid and semi-rigid plastic samples » Versatile grip for many materials » Interchangeable faces available | <ul style="list-style-type: none"> » Economical manual grip » Many faces, sizes and profiles » Large specimen opening is good for a variety of tests | <ul style="list-style-type: none"> » Economical manual grip » Best for thin specimens » Fewer grip face options available |

GRIP FACE OPTIONS*

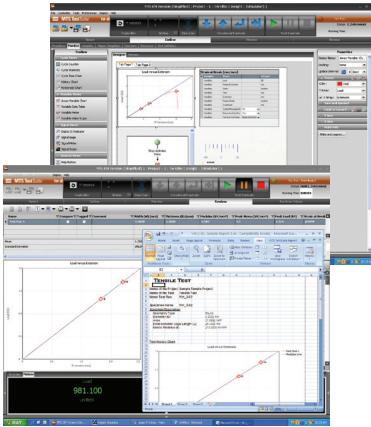
|  |  |  | ASTM D638 Gripping Guidance The grips must secure the specimen to prevent slipping, but at the same time not induce stresses that can lead to misleading failures. The grip faces should be wider than the specimen under test. |
|---|--|--|---|
| Serrated Grip Faces | Diamond Tip Faces | Flat Rubber Faces | |
| <ul style="list-style-type: none"> » Versatile and the most common | <ul style="list-style-type: none"> » good for thicker, more durable specimens | <ul style="list-style-type: none"> » Used for thinner, more fragile specimens | |

EXTENSOMETRY OPTIONS*

The stress strain curves for plastics most often contain a linear elastic region, as well as a non-linear plastic region. Modulus needs to be measured within the linear elastic portion, where very little strain exists. This is why accuracy is an important factor in determining the right extensometry for your test. Extensometers with high accuracy typically have limited travel and must be removed from the specimen during the test.

|  |  |  |  |
|--|--|--|---|
| Video | Auto | High Elongation | Clip-on |
| <p>MTS Advantage™ Video Extensometer (AVX) delivers the highest quality in non-contact strain measurement.</p> | <p>The MTS MF Automatic Extensometer allows release prior to break and also has an automated gage length set-up.</p> | <p>MTS Advantage AHX850 High Elongation Extensometer has an adjustable, low-impact specimen contact force that is especially good for fragile materials.</p> | <p>MTS Model 634 Series Clip-On Extensometers are good for measuring modulus.</p> |

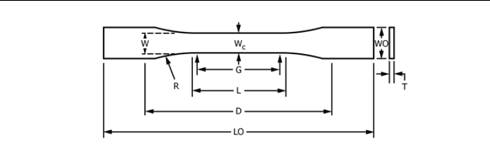
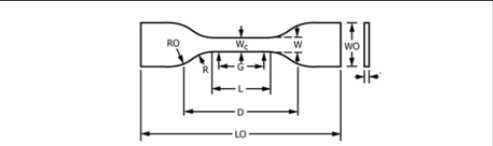
SOFTWARE OPTIONS*



| ASTM D638 Tensile Properties of Plastics Test Template | About TestSuite™ TW |
|--|---|
| <p>To simplify testing to ASTM D638, MTS has developed a TestSuite™ TW test template that will set up and run the recommended tensile tests. After the test data has been collected, reports can display all of the required calculations including tensile strength, elongation at yield, elongation at break, nominal strain at break, modulus of elasticity, secant modulus, Poisson's ratio, and more.</p> <p>MTS consultants are also available to support any of your plastics applications, test method set-up, and data collection and integration requirements.</p> | <p>This flexible and versatile software application comes in three versions so that you can choose exactly which one best fits your requirements. Lab managers and test creators like TW Elite since it includes all the test definition capacity and flexibility needed to create and edit custom test sequences while accommodating the specific runtime needs of lab personnel. Test operators prefer the simplicity and intuitive nature of TW Express. This software allows operators to easily execute tests and monitor data or calculated values in runtime views. For QA/QC labs that prefer the MTS Exceed universal test machine, TW Essential will provide both the test creation and test operation capabilities, combining efficiency and productivity in one software application.</p> |

*NOTE: This technical note is intended to show some of the popular and more common solutions used for this particular application. Most of the time, additional options are available and necessary to accomplish your more comprehensive test objectives.

APPENDIX - TEST SPECIMEN DETAIL

|  |  |
|---|---|
| Specimen Shape** for Types I, II, III & V | Specimen Shape** for Type IV |
| <p>Rigid and Semi-Rigid Plastics. Type I is the preferred where sufficient material having a thickness of 7 mm (0.28 in) or less. Type II specimen is recommended when a material does not break in the narrow section with the Type I. Type V specimen shall be used for limited availability material having a thickness of 4 mm (0.16 in) or less, or where many specimens are to be exposed in a limited space like a chamber. Type III specimen must be used for all materials with a thickness of greater than 7 mm (0.28 in) but not more than 14 mm (0.55 in).</p> <p>Nonrigid Plastics. Type III specimen must be used for all materials with a thickness greater than 7 mm (0.28 in) but not more than 14 mm (0.55 in).</p> <p>Reinforced Composites. ALL reinforced composites, including highly orthotropic laminates, shall use Type I specimens.</p> | <p>Rigid and Semi-Rigid Plastics. Type IV specimen is generally used when direct comparisons are required between materials in different rigidity cases.</p> <p>Nonrigid Plastics. Type IV specimen shall be used for testing nonrigid plastics with a thickness of 4 mm (0.16 in) or less.</p> |

*NOTE: Consult ASTM D638 for more detailed Type I, II, III, IV and V dimensions.



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