

User Benefits

- ◆ Tensile testing of plastics conforming to ASTM D638 is possible.

■ Introduction

Tensile properties are basic evaluation items for understanding the characteristics of plastic materials. Mechanical properties such as strength, elastic modulus, and elongation can be quantitatively evaluated by investigating the stress-strain behavior when a tensile load is applied to the material. This makes it possible to obtain indices for understanding the strength and deformation behavior of the material under the actual use environment. ASTM standards are established by ASTM International, and ASTM D638 specifies the test piece geometry and test conditions for tensile tests of plastics. Since compliance with this standard enables data acquisition under uniform conditions, it is widely used as a test method for objective comparisons of differences between materials and various molding conditions.

This article introduces an example of tensile testing of plastics conforming to ASTM D638 (revision of December 15, 2014) using a Shimadzu AGS™-V precision universal testing machine (Fig. 1).



Fig. 1 Precision Universal Testing Machine (AGS™-V)

■ Test Conditions

Table 1 shows the test conditions, and Table 2 shows the specimen information. Tests of polypropylene (PP), polycarbonate (PC), and polyvinyl chloride (PVC) were conducted 5 times with each material, and the average values and standard deviations of various mechanical properties were calculated. Fig. 2 and Fig. 3 show the condition of the test. As the specimen geometry, a Type I specimen was selected for this test, as use of this type is recommended when ample material with a thickness of 7 mm or less is available. To eliminate deflection of the specimens, stabilize the initial conditions, and improve repeatability of the measurement, a preload of 5 N was applied.

Table 1 Test Conditions

Testing machine	: AGS-10kNVD
Load cell	: 5 kN
Testing jig	: 5 kN pneumatic flat grip
Gripping teeth	: Single-cut file teeth
Air pressure	: 0.4 MPa
Software	: TRAPEZIUMX-V (Single)
Test speed	: 50 mm/min
Gauge distance	: 50 mm
Grip distance	: 115 mm
Extensometer	: TRViewX 240S non-contact digital video extensometer
Sticker-type gauge marker	: Line sticker-type gauge marker

Table 2 Specimen Information

Types of specimens	: Polypropylene (PP) Polycarbonate (PC) Polyvinyl chloride (PVC)
Number of specimens	: 5 of each type
Specimen geometry	: Dumbbell shaped Type I
Original dimensions of parallel part	: Width 13 mm × thickness 3.2 mm

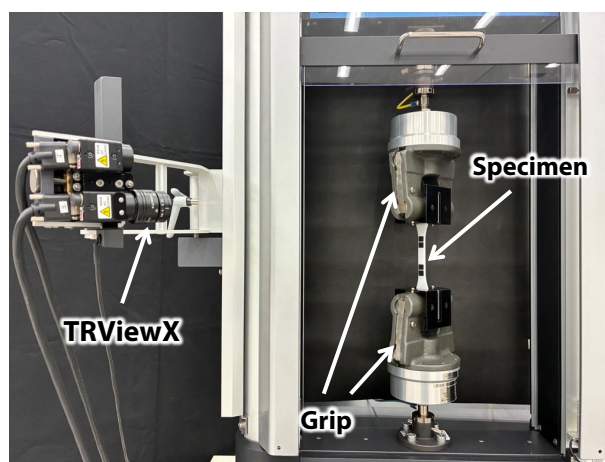


Fig. 2 Overview of Test Setup (Appearance Including TRViewX and Jig)



Fig. 3 Enlarged View of Test Setup

■ Test Results

Fig. 4 shows an example of the test results for PP, PC, and PVC. The strain on the horizontal axis shows values converted from the extensometer output, while the stress on the vertical axis shows values calculated using the cross-sectional areas obtained from the average values of measurements of the width and thickness of the parallel part at three points each. Table 3 shows the tensile strength, total elongation (breaking elongation), and the elastic modulus of each specimen material. Although there were some variations in the total elongation, the standard deviations of tensile strength and the elastic modulus were small, confirming good repeatability.

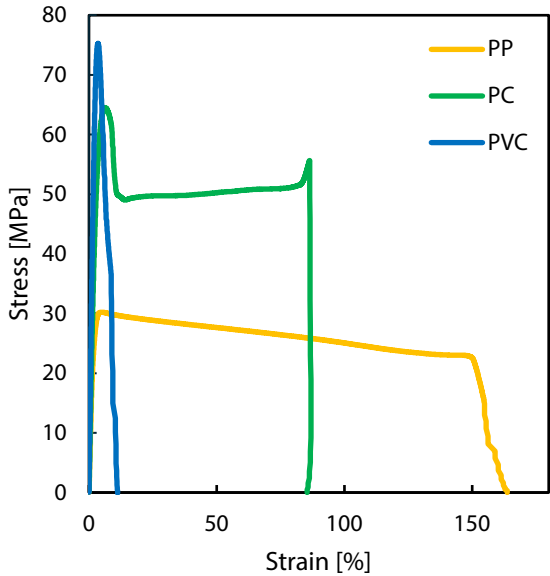


Fig. 4 Stress-Strain Curves

Table 3 Test Results of Specimens (n = 5)

		Tensile strength [MPa]	Total elongation [%]	Elastic modulus [GPa]
PP	Average	30.4	156.1	1.76
	Standard deviation	0.23	42.2	0.072
PC	Average	64.6	65.0	2.19
	Standard deviation	0.19	34.7	0.11
PVC	Average	75.3	4.8	3.13
	Standard deviation	0.15	0.6	0.18

■ Conclusion

This article introduced an example of an ASTM D638-compliant tensile test of plastic materials using a Shimadzu AGS-V precision universal testing machine. In evaluations of plastic materials, the tensile strength, total elongation, elastic modulus, and other mechanical properties specified in ASTM D638 are important indices for understanding the strength, stiffness, and deformation behavior of products. Since these properties are directly related to material selection corresponding to the intended application and assurance of safety and reliability when designing products, a proper evaluation is required.

Tensile tests of plastics conforming to ASTM D638 can be conducted by using the Shimadzu AGS-V precision universal testing machine.

Related Application

1. Tensile Test of Plastic Materials, [Application News No. i253](#)

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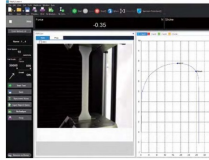
Related Products

Some products may be updated to newer models.



› AUTOGRAPH AGS-V Series

Tabletop Precision Universal Testing Machines



› TRAPEZIUMX-V

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