

# Application News

Material Testing Machine

No.i239

## Breaking Strain Measurement of ABS Resin

### ■ Introduction

Increasingly high performance engineering resins are being developed for use in a wide range of fields, such as the automotive industry, consumer electronics, office automation equipment, for their various functional characteristics. Some of the criteria that have become especially important for evaluating the performance of such materials is impact resistance and its associated material properties, such as strength and rigidity. In addition to evaluating materials in terms of conventional static tensile strength, high-

rate tensile strength, longitudinal elasticity, and strain measurements up to the breakpoint are expected to become important new parameters for materials development. This example describes testing the high-rate tensile strength of a flat plate specimen of ABS resin and measuring strain up to the breakpoint. Images of the high-rate tensile test were captured with a high-speed video camera and image analysis software was used to measure the strain between gauge length on the specimen.

### ■ Tensile Test Specimen

Fig. 1 shows the dumbbell-shaped flat ABS resin tensile test specimen mounted in the grips of the high-rate tensile testing machine. A chuck extensometer, capable of measuring the relative displacement of the fixed end and the upper grip, is attached to the top right of the specimen. A matrix of black dots is printed on the surface of the specimen. The strain between gauge length can be measured by using a high-speed video camera to record a moving image of the tensile test and automatically tracking the movement of the specified dots.

- (1) Specimen Material: ABS resin
- (2) Specimen Dimensions: 110 (L) × 10 (W) × 3 (T) mm and 19 mm wide grip tab
- (3) Dot Specifications: 0.5 mm diameter, spaced 2 mm apart

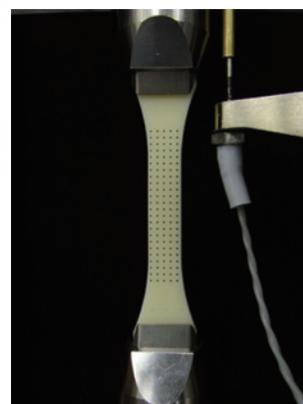


Fig. 1 Tensile Test Specimen Mounted in Grips

### ■ Measuring High-Rate Tensile Strength and Recording Video Image

Tensile testing was performed using the HITS-T10 hydroshot hydraulic high-rate tensile testing machine. The HPV-2A high-speed video camera was mounted in front of the testing machine to capture 100 video frames of the specimen behavior during tensile testing. Conditions for tensile testing and recording video in this example are indicated below.

- (1) Tensile Rate : 3 m/s
- (2) Grip Distance : 75 mm
- (3) Gauge Length for Measuring Strain : 30 mm
- (4) Test Force Measurement : 10 kN load cell
- (5) Data Collection : 250 kHz
- (6) Recording Speed : 32 kfps
- (7) Light Source : Metal halide light



Fig. 2 Setup of High-Rate Tensile Test and Video Recording

### ■ Video of High-Rate Tensile Test of ABS Resin

Images of the ABS resin specimen (4 frames) before and after breakpoint during the high-rate tensile test are shown in Fig. 3. In this example, the recording

speed was 32 kfps. The interval between frames was 32 microseconds.



Fig. 3 Four Frames of Specimen Before and After Breakpoint

### ■ Breaking Strain Measured from Images

A time history of strain between gauge length is determined by using image analysis software to analyze the images obtained. In this case, gauge length was specified longitudinally 30 mm apart on an image of the specimen not moving (16 consecutive dots apart at the center of the specimen), then that gauge length was automatically tracked as a function of time to measure the longitudinal strain. The resulting time history of strain obtained is shown in Fig. 4. In addition, a time history of stress measured by the high-rate tensile testing machine or external data logger can be displayed simultaneously as well. Furthermore, images are displayed synchronized with strain and stress in terms of time. This tensile test example resulted in a tensile strength and breaking strain of ABS resin that was 70 MPa and 30 %, respectively.

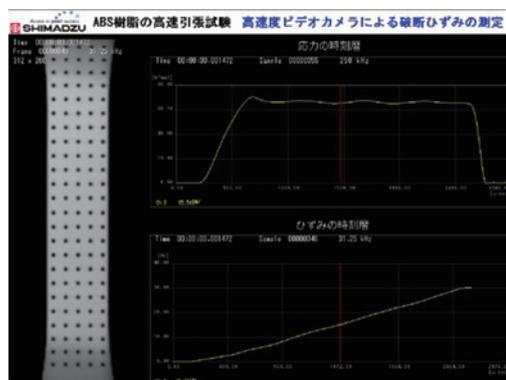


Fig. 4 Video of Tensile Test and Time History of Strain and Stress

### ■ Determining Stress-Strain Relationship in High-Rate Tensile Test

Producing a stress-strain curve, which is easy for static tensile testing, is an extremely difficult technical challenge for high-rate tensile testing.

Strain gauges can only measure a small range and contact type extensometers do not work for shock. In this example, a stress-strain curve was obtained for ABS resin by synchronizing the video image timing with the test force.

A stress-strain curve up to the specimen breakpoint is shown in Fig. 5.

In this way, combining a high-rate tensile testing machine, high-rate video camera, and image analysis software, enables simultaneously evaluating high-rate tensile properties, including breaking strain, and visualizing changes in the status of resins.

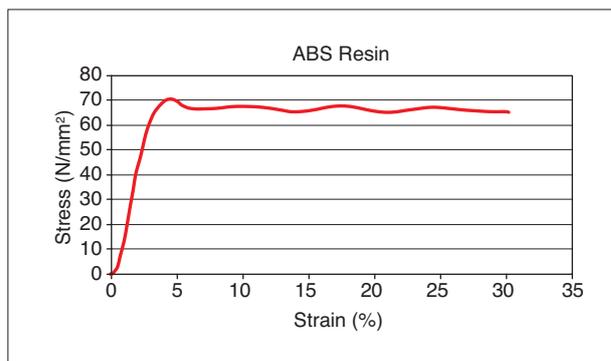


Fig. 5 Stress-Strain Curve up to Breakpoint