LAAN-A-AG-E007

SHIMADZU

Application News

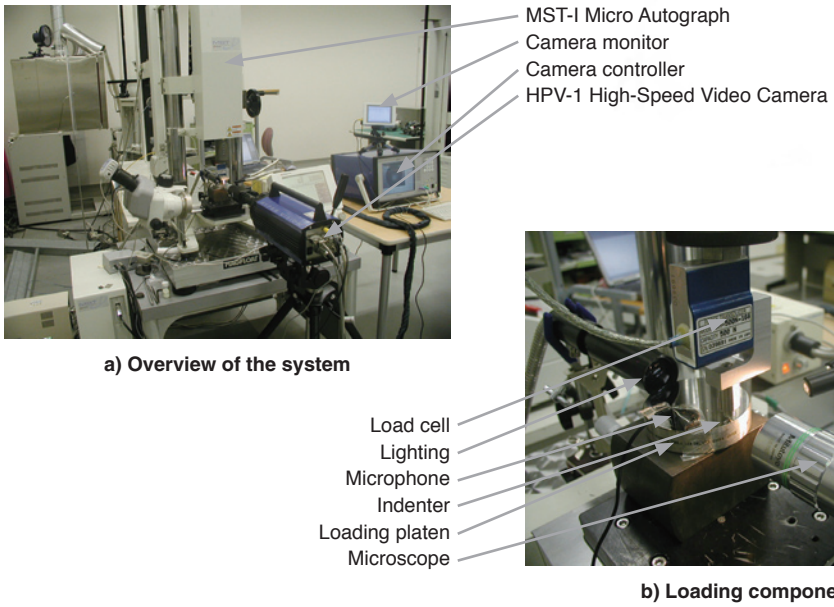
Material Testing System No.i202

Observation of Destruction of Micro Glass/Plastic Beads

■ Introduction

In extending the durability of various products, the evaluation of strength is an important element for developing materials that comprise these products. For example, measuring the strength of each particle of a particulate material and observing the destruction process at the same time is useful for gaining information for looking into the case of material fragility, for example, and solving problems.
This time, a compression destruction test was performed on micro glass beads and micro plastic beads using the MST-I Micro Autograph, and images of their destruction were taken at the same using the HPV-1 High-Speed Video Camera, which is capable of taking photos at an ultra-high speed of 1 million frames/second. Application of micro-granular particles is spreading to various spacer materials, for example, and the evaluation of their mechanical performance is meaningful.
The following introduces an example of photos taken when micro particles were destroyed instantly in the strength evaluation process.

■ Testing system and results



a) Overview of the system

b) Loading component

Fig. 1 Overview of MST-I and HPV-1 Experimental System

Fig. 1 shows an overview of the compression test with a system comprising the MST-I Micro Autograph and HPV-1 High-Speed Video Camera. In this test, a compression load was applied to a glass bead of diameter 450 µm and a plastic bead of diameter 260 µm by a flat indenter of diameter 500 µm, the relationship between force and displacement in this process was measured, and the destruction of the specimens was photographed by the high-speed video camera at the same time. The sound that occurs when the specimen breaks was captured by a small microphone and used as the image capture start (trigger) signal of the high-speed video camera. Also, a microscope (field-of-view: approx. 630 × 520 µm) unit that contains a 20X objective lens was used as the optical unit on the camera, and one 350 W and 100 W Halogen lighting unit each was used for lighting.

Name	Max. Force	Breaking Strength	Particle Size
Unit	N	MPa	μm
Glass bead	54.58	240.2	450.
Plastic bead	13.79	181.8	260.

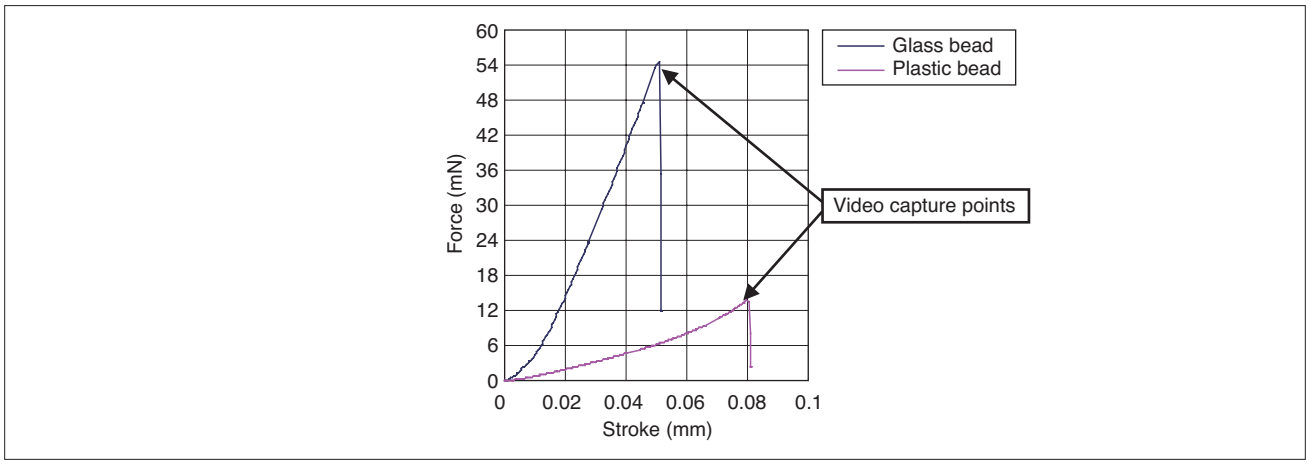


Fig. 2 Results of Compression Test for Micro Beads

Fig. 2 shows the results of the compression test on the two types of beads. The graph shows the force-stroke (amount of indenter movement) for each specimen. From this graph, it can be seen that destruction occurs rapidly at the point where the force drops significantly.

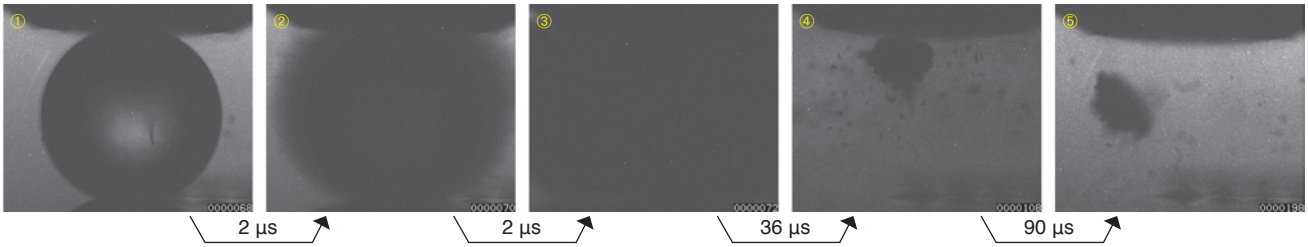


Fig. 3 Fragmentation of the Grass Bead (Frame Rate 500,000 fps)

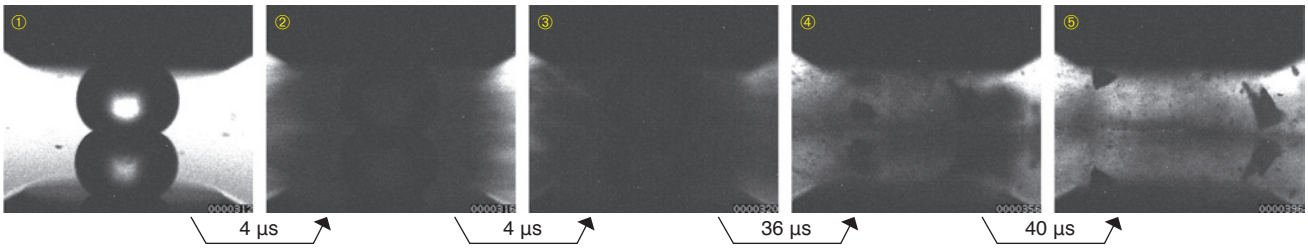


Fig. 4 Fragmentation of the Plastic Bead (Frame Rate 250,000 fps)

Fig. 3 (glass bead) and Fig. 4 (plastic bead) show some of the continuous images captured by the high-speed video camera of the instant that each specimen is destroyed. The numbers (1) to (3) in each photo are of the image feed one frame at a time and are continuous images at the respective image capture speed.
These images show that destruction occurs on each specimen during one frame as state (1) transitions to state (2) and that this destruction is explosive. Also, subsequent images capture the process where fragments scatter. It is observed that fine fragments spread in the entire field-of-view and then gradually become fewer and fewer.

As shown in this example, the instantaneous destruction of small specimens can be captured as continuous sharp images by combining the MST-I Micro Autograph with the HPV-1 High-Speed Video Camera, and this capability is considered a possible means of obtaining major clues in learning the physical properties of various materials.

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