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Advanced Video Extensometer (AVE) Marking Techniques for Soft Tissue Testing

Extensometers are often used to accurately measure the deformation of a material under mechanical loading. Due to the fragile nature of biological soft tissues, such as fascia, skin, and intestinal lining, a non-contacting extensometer is the ideal solution for measuring tensile strain in these specimens.

The AVE uses a high-resolution digital camera and advanced real-time image processing to make precise axial and transverse (optional) strain measurements on test specimens. Because these tissue specimens are soft, moist, and vary in color, the challenge in acquiring strain data lies in the marking technique. The purpose of this study was to investigate different AVE marking techniques for biological tissues.

AVE marking using graphite-cyanoacrylate dots

Test Configuration and Sample Preparation

The Instron® 5969 frame was configured with a 100 N load cell and the AVE. A 200 mm Field of View (FOV) lens was used for all tests. Based on previous analysis, pneumatic grips provide the best gripping solution for soft tissues because they allow the user to specify the gripping pressure. In combination with 25 mm x 50 mm serrated faces and a gripping pressure of 50 psi, slipping of the specimen was minimized and damage was prevented.

Strips of pig intestine were used for the testing procedure. The specimens had an approximate thickness of 0.3 mm, length of 75 mm and a width of 25 mm. The grip separation (gauge length) was set to be 25 mm.

Marking Technique Number 1: Paper Dots

The simplest marking technique investigated was the use of small black or white paper dots. A dot with a diameter of 3.5 mm was ideal for the specimen dimension specified and were placed on the specimen without the use of adhesive material. These dots remained on the specimen through failure.

Marking Technique Number 2: Graphite Powder and Cyanoacrylate

Black graphite powder was mixed with cyanoacrylate (superglue). Small droplets of the solution were placed onto the specimen, as seen in the photo above. A white background was necessary to enhance the contrast between the graphite-cyanoacrylate dots and the specimen. Because the intestine specimens are soft and flexible, it was best to load the specimen into the grips before marking.

Marking Technique Number 3: Cyanoacrylate

Small droplets of cyanoacrylate were also investigated. Specimen marking was performed prior to loading in the grips and on a flat surface to attain proper alignment of the marks. Within seconds of applying the solution to

the specimen, the solution hardened and turned white, providing significant contrast between the specimen and the marks with the AVE.

Results

The AVE was able to detect the marks for all three techniques investigated. .

Conclusions

When investigating the use of marking techniques for measuring strain in soft tissues, it was important to ensure that the marks were visible to the AVE camera and software, that the marks did not damage the specimen or alter the results in any way, and that the application of these marks required only simple technique. These criteria were satisfied in all three of the discussed marking techniques.

The selection of a marking technique depends on the testing environment and the nature and dimensions of the tissue sample. For example, although the adhesive dots were the easiest to use and apply, this technique would not be appropriate for extremely moist specimens or testing in a bath, as the moisture will prevent adhesion to the tissue. For small, thin specimens, the graphite-cyanoacrylate technique is recommended because the black marks are easy-to-see and the dot size is small.

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