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Tensile Testing of Hydrogels | In a Temperature-Controlled Bath

Hydrogels are widely used in the biomedical industry for applications such as coatings for catheters, contact lenses, scaffolds, and wound dressings because these materials have the ability to absorb fluids and swell up to 2000 times their original size. Hydrogels are often implanted into the body to provide medical benefits and therefore must be tested in a simulated environment.

There are many challenges in testing hydrogels. Loading the specimen alone, can pose many problems as the material is not only slippery, but also delicate and can easily fracture. Many grips apply too much pressure to the specimen and faces are too rough, causing the specimen to fail before testing can even begin. Further, because these specimens fail at such low forces, highly accurate load and extension measurements are required. Hydrogels also necessitate the use of a temperature-controlled bath at 37 °C to maintain physiological conditions throughout the mechanical evaluation. Testing under ambient conditions results in the drying out of the material and consequently, a signficant change in the mechanical properties.

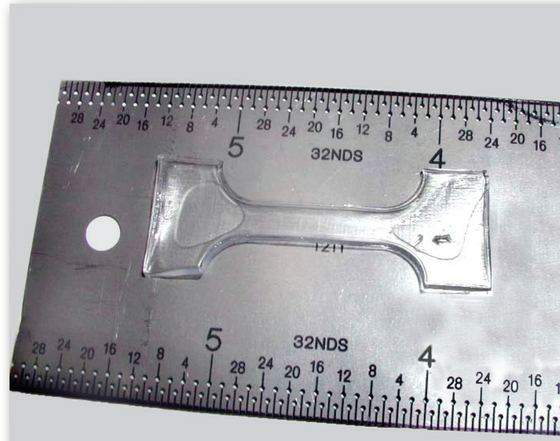

Figure 1:
Close-up of a hydrogel specimen.

Test Configuration and Sample Preparation

A 5544 electromechanical test frame configured with a 10 N load cell and the Instron® BioPuls™ 250 N capacity submersible pneumatic grips with 25 x 25 mm surfalloy faces were used for this test. The BioPuls Bath was also used in order to keep the specimen hydrated and test the material in an in vitro envrionment. One of the specimens used in these tests is shown in Figure 1. The test methodolgoy called for a gauge length of 5 mm and a test speed of 5 mm/min. The complete test configuration is shown in Figure 2.

In order to ensure that the specimen was not crushed when inserted into the grips, the distance between the faces was slightly increased prior to specimen loading.

The most common method for characterizing hydrogels is a basic tensile test to failure, which Bluehill® 2 can easily preform. This test method was used to evaluate maxium load, extension at maxium load and tensile strain at the maxium load, as well as the modulus for two hydrogel specimens from two different samples.

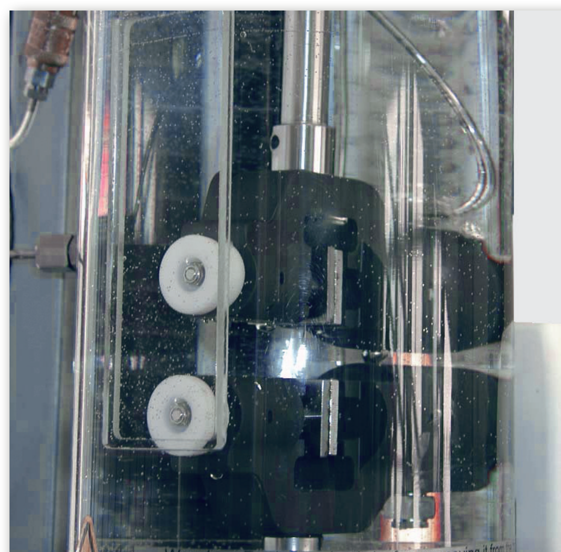

Figure 2:
The recommended test configuration for testing hydrogels includes the BioPuls submersible pneumatic grips and temperature-controlled bath.

Products for Materials Testing

Results

The results show that this test configuration was successful in testing hydrogel specimens and was able to accurately measure the low force fracture. The data was fairly consistent and is shown in Figure 3 and Table 1.

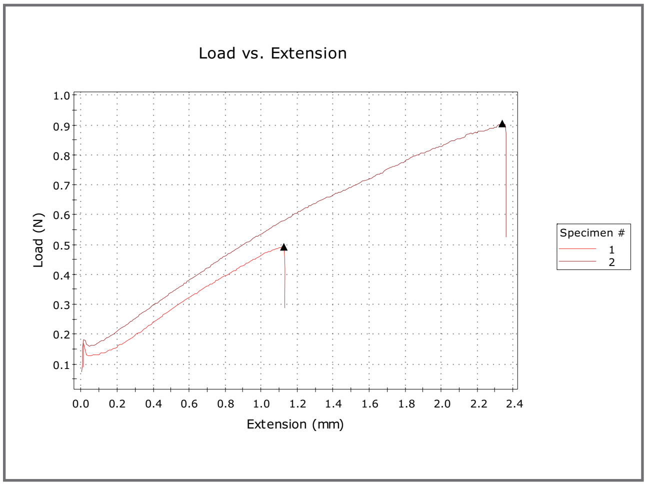

Figure 3:
Load vs. Extension results for two hydrogel specimens tested to failure.

	Max Load	Extension at Max Load	Tensile Strain at Max Load	Modulus
	N	mm	%	MPa
1	0.493	1.125	22.2	0.605
2	0.904	2.340	46.7	0.609
Mean	0.698	1.732	34.4	0.607
S.D.	0.291	0.860	17.3	0.003

Table 1:
Results for two hydrogel specimens tested to failure.

Conclusions and Recommendations

In conclusion, hydrogels can easily be tested using the previously described configuration. It is recommended that the distance between the faces be increased slightly before specimen loading to decrease the chance of breaking or crushing the material upon grip closure.

Configuration Table

Catalog Number	Configuration Options	Description
5544	Frame	Single column test frame
2530-428	Load Cell	10 N Capacity
2752-005	Grips	250 N BioPuls™ Submersible Pneumatic Grips
2702-206	Faces	25 mm x 25 mm surfalloy faces
3130-100	Bath	BioPuls temperature-controlled bath
2410-270U1	Software	Bluehill® 2 software with tension application

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