Tension Testing of Thin Filaments

Overview

Accurate, ultra-low force tension testing of materials can be difficult to achieve due to noisy data. When this occurs, it can lead to inaccurate analysis and conclusions.

This report outlines the results of ultra-low force tension testing of an elastic filament using CellScale's Eclipse force sensor. The data was then analyzed using CellScale's Data Analysis software to find the elastic modulus of the filament.

This resulted in accurate and precise data outputs which led to an accurate characterization of the elastic filament.

Methods

The elastic filament samples were held by CellScale's low force spring grips. This ensured the gripping force does not damage the sample, while preventing it from slipping.

A 50 mN Eclipse force sensor was used for testing 4 different samples of the same elastic filament material. Each sample was preloaded to 2 mN to ensure uniform initial conditions, followed by a 5% strain (Figure 1). The gauge length of each sample was defined as the length after the preload was achieved. The CellScale Data Analysis software was used to calculate the stress-strain curve based on the collected force-displacement data of each test and the cross-sectional area of each sample (Figure 2). The modulus of elasticity was found for each sample and averaged to characterize the elastic filament material.

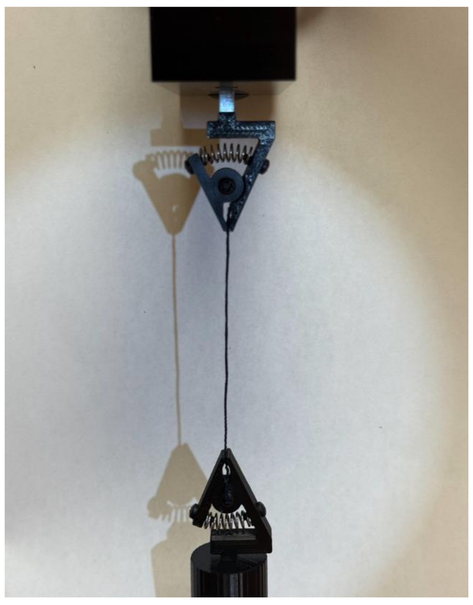

Figure 1: Filament sample held by the low force spring grips. This setup was lit using gooseneck lights

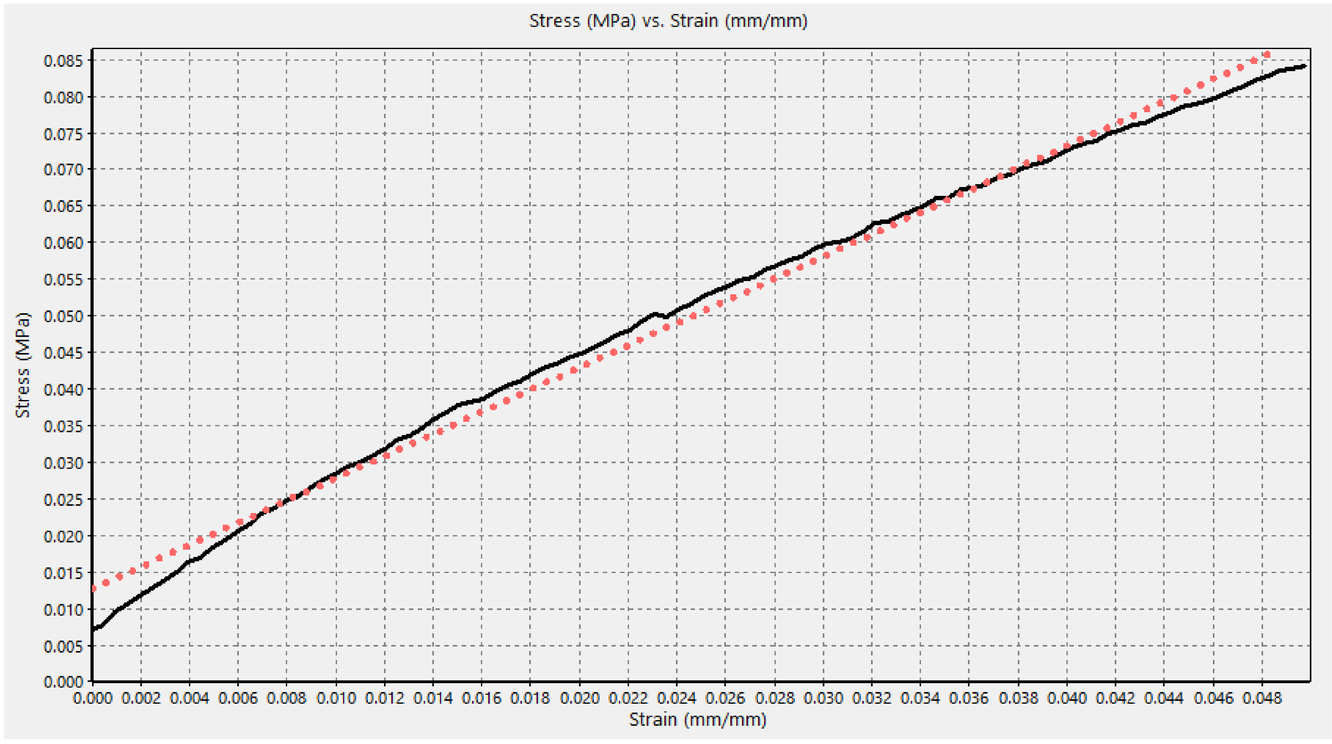

Figure 2: Stress-strain graph of sample 1, with trend line superimposed in red dotted line

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Results and Analysis

The slope of each stress-strain curve was calculated using the curve fit function in the Data Analysis software. The modulus of elasticity of the material was then calculated from the values of the stress-strain curves slopes. A report on the material modelling of each sample was also produced to summarize the calculated values. This can be seen in Figure 3.

The Data Analysis software compared the graphed slopes across each sample as seen in Figure 4. The calculated values were then averaged to find the modulus of elasticity of the filament material.

As seen in Table 1, the calculated modulus of elasticity for this filament material was 1.520 MPa with a standard deviation of 0.100 across 4 samples.

Conclusions

Ultra-low force tension testing was done on 4 samples of the same elastic filament using CellScale's Eclipse force sensor to characterize this material. The test results were analyzed to find the modulus of elasticity of each sample and averaged to characterize the filament material. The average calculated modulus of elasticity was 1.520 MPa.

Primary Axis

Maximum Load (mN)	23.90
Maximum Stress (MPa)	0.08
Maximum Grip Strain	0.05
Break Detected	False
Elongation At Break (mm)	50.63
Ultimate Strength (At Break) (MPa)	0.08

test

Modulus Of Elasticity (MPa)	1.51
R^2	0.99
Set	All
Cycle	All
Phase	Stretch

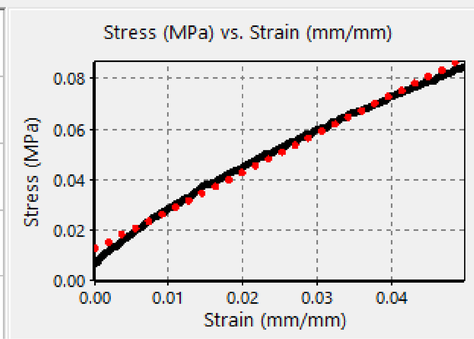

Figure 3: Report for a single test from Data Analysis

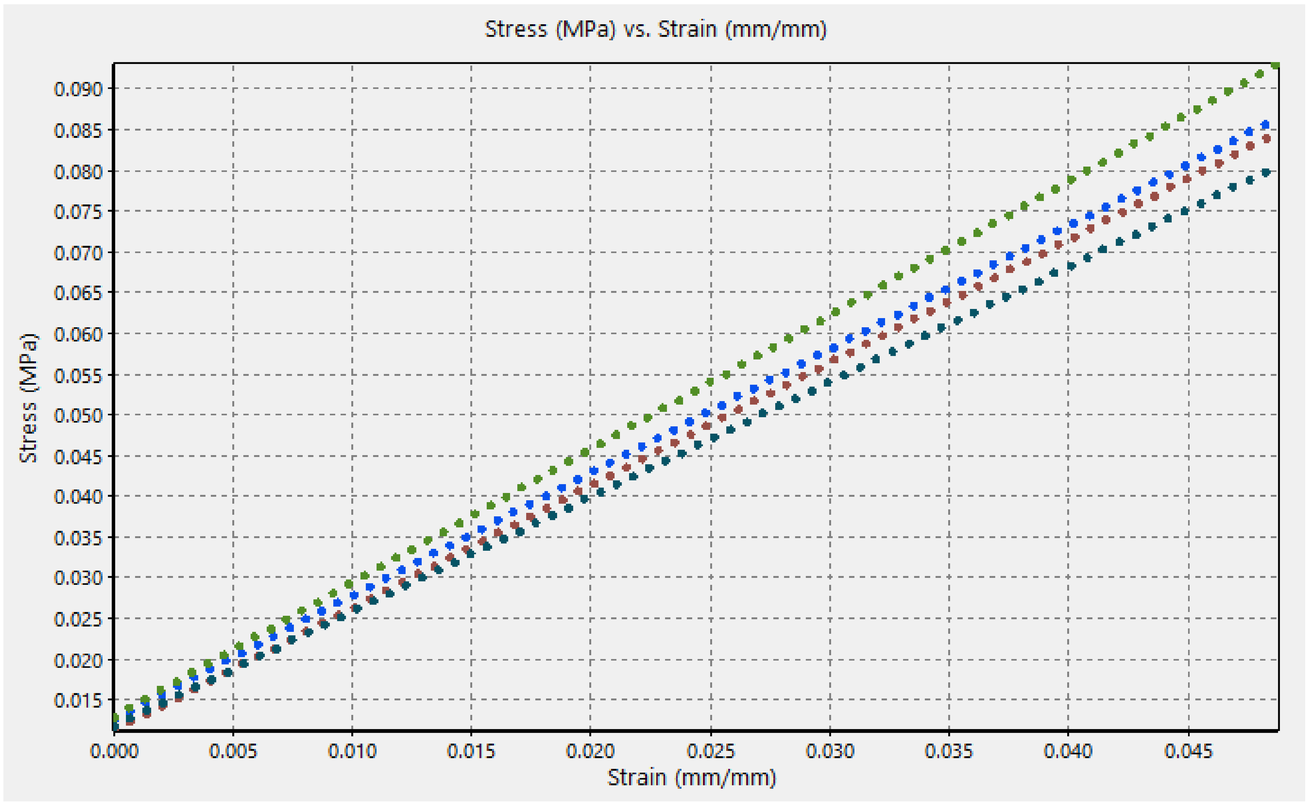

Figure 4: Slopes of each test approximated by curve fit in Data Analysis.

Table 1: Material properties

	Average (Mean)	Standard Deviation	Minimum Value	Maximum Value
Modulus Of Elasticity (MPa)	1.520	0.100	1.410	1.640
Maximum Load (mN)	23.850	1.383	22.400	25.700
Maximum Stress (MPa)	0.080	0.000	0.080	0.090
Maximum Strain	0.050	0.000	0.050	0.050

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