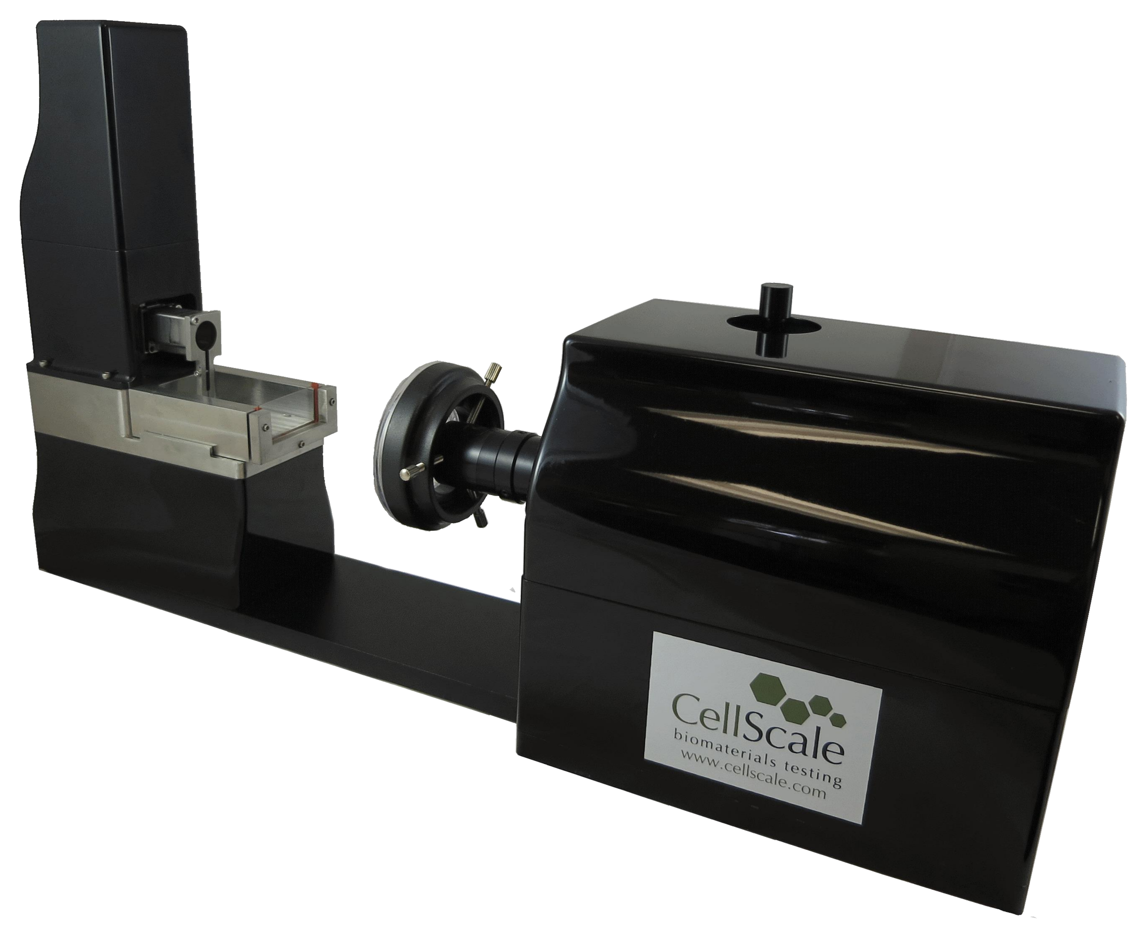
Tension Testing of Filaments

Overview

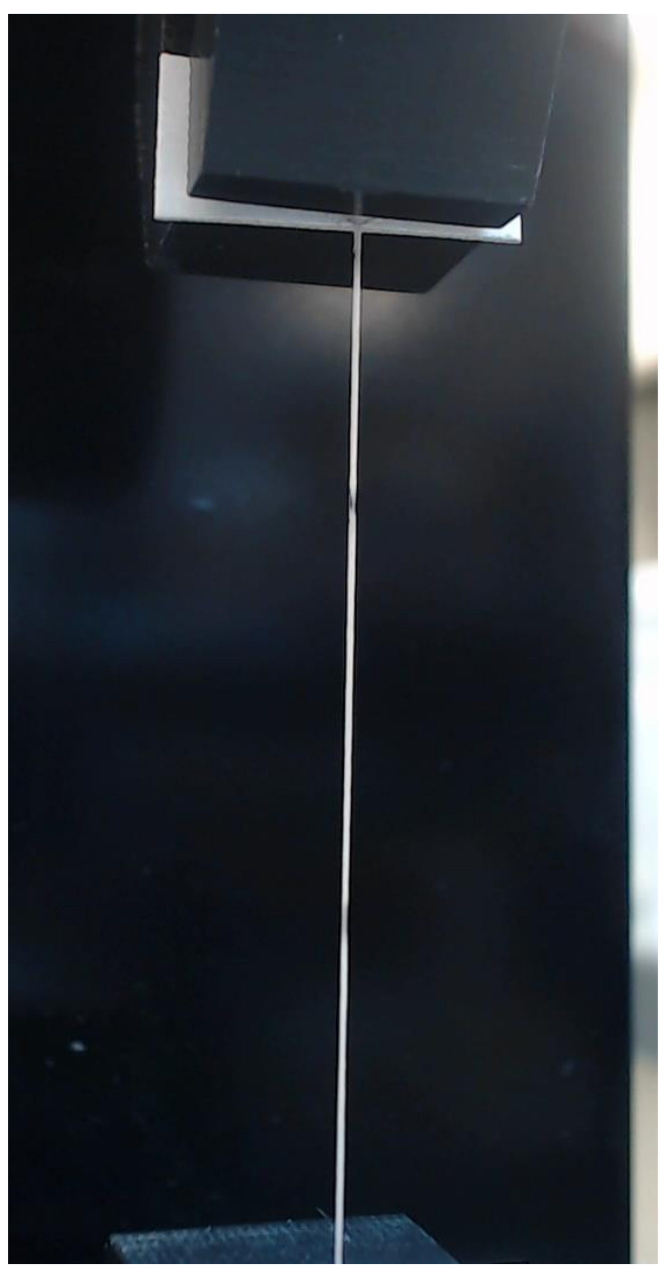
Tension testing of soft material filaments can be difficult due to fixation challenges. The use of mechanical jaws often results in crushing the specimen or slippage of the specimen under load. Manual positioning of the specimen in proximity to a sensitive load sensor can also result in unwanted damage.

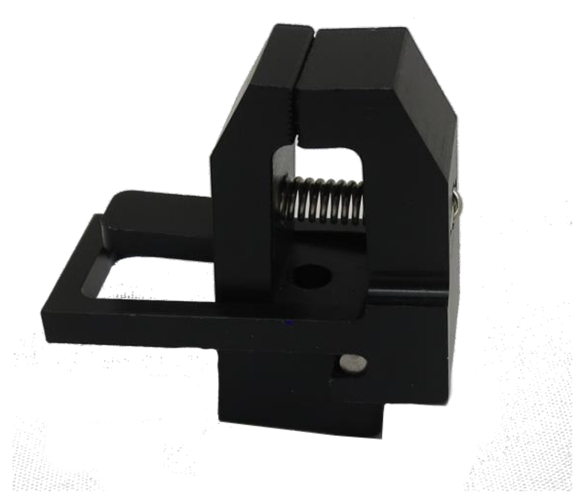


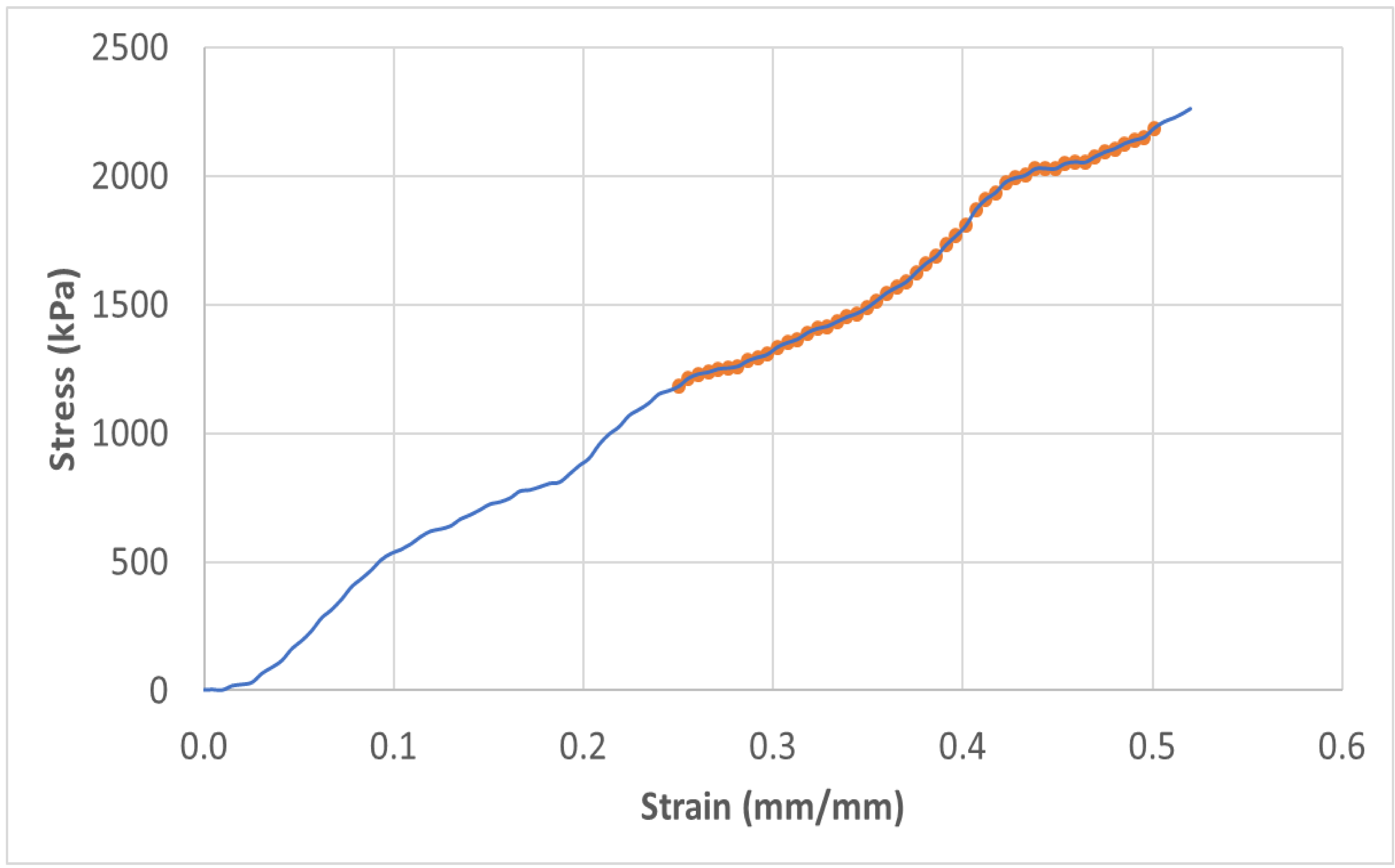
This report outlines the results of tension testing of an elastic filament using 2 methods: mechanical grips and a conventional load cell (UniVert) and 3-point tension testing with a high-resolution force transducer and high-magnification imaging (MicroTester). The 3-point technique varies from the conventional in-line technique in that the force sensor does not need to be fixed to the specimen. This difference simplifies the test setup for small, delicate samples.

Uni-axial Tension Testing

To achieve adequate fixation, the filament was fixed with adhesive to small plastic tabs. The adhesive assures maximum contact area between the tab and the specimen in order to transfer the force without damaging the filament. The tabs are strong enough to be gripped by the mechanical jaws of the UniVert system without breaking or slipping. A 10N load cell was used and the filament was stretched to 50% strain.







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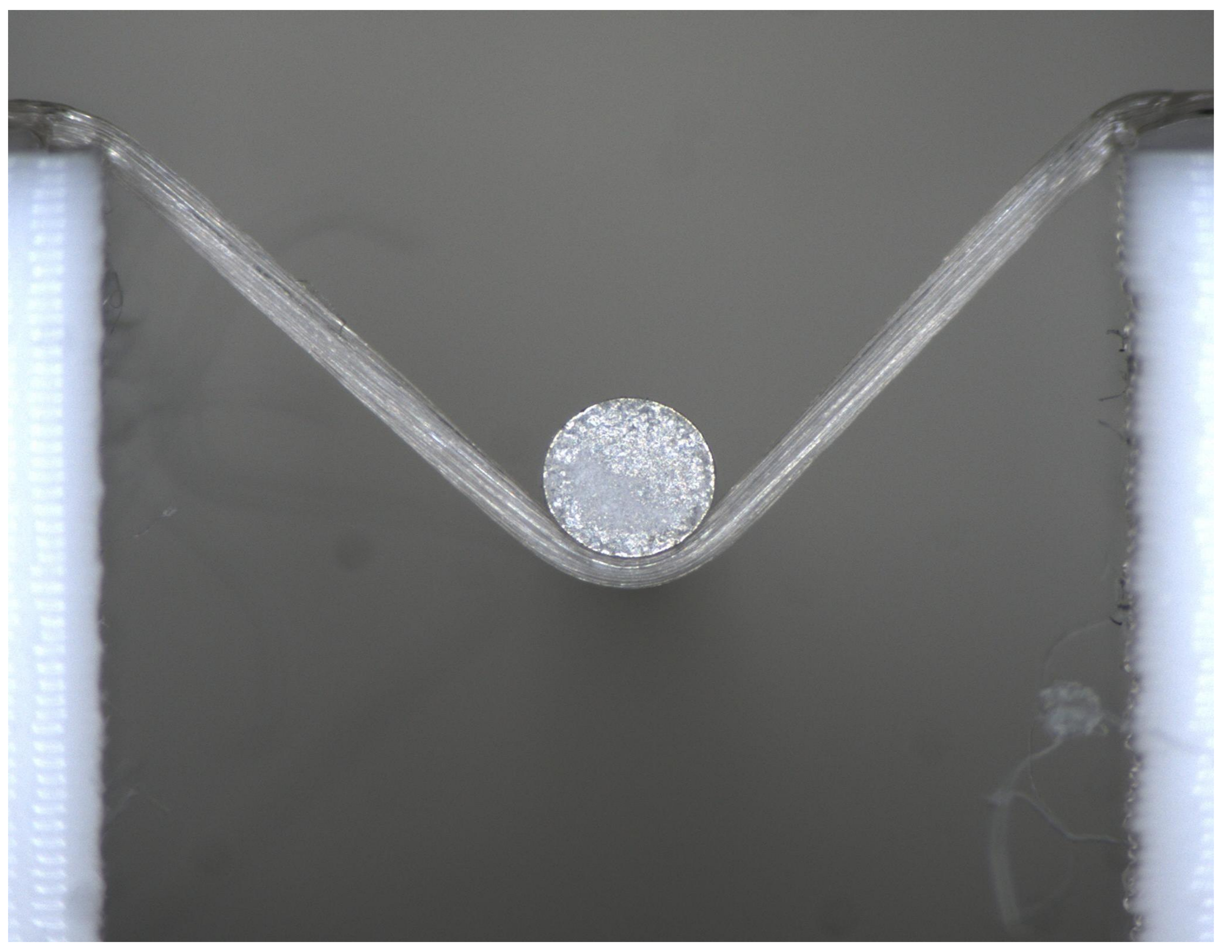
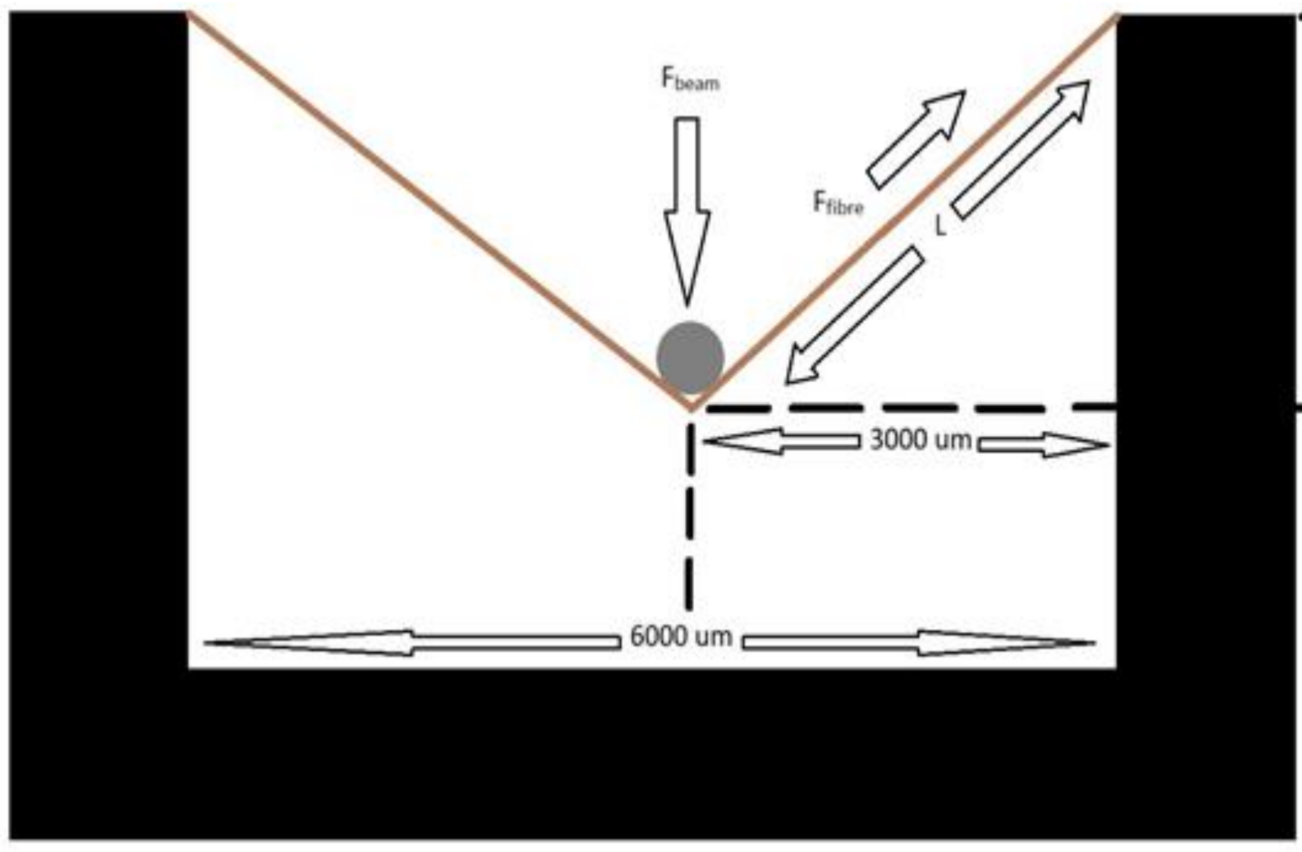
3-Point Tension Testing

For this test, the filament specimen was placed across a bridge fixture with 6mm spacing and fixed with adhesive at either end. A MicroTester probe tip was placed at the midpoint and moved in a downward direction. This movement has the effect of stretching the filament and 50% strain was achieved. Force and displacement values along the length of the filament were calculated from the vertical measurements using trigonometric equations.



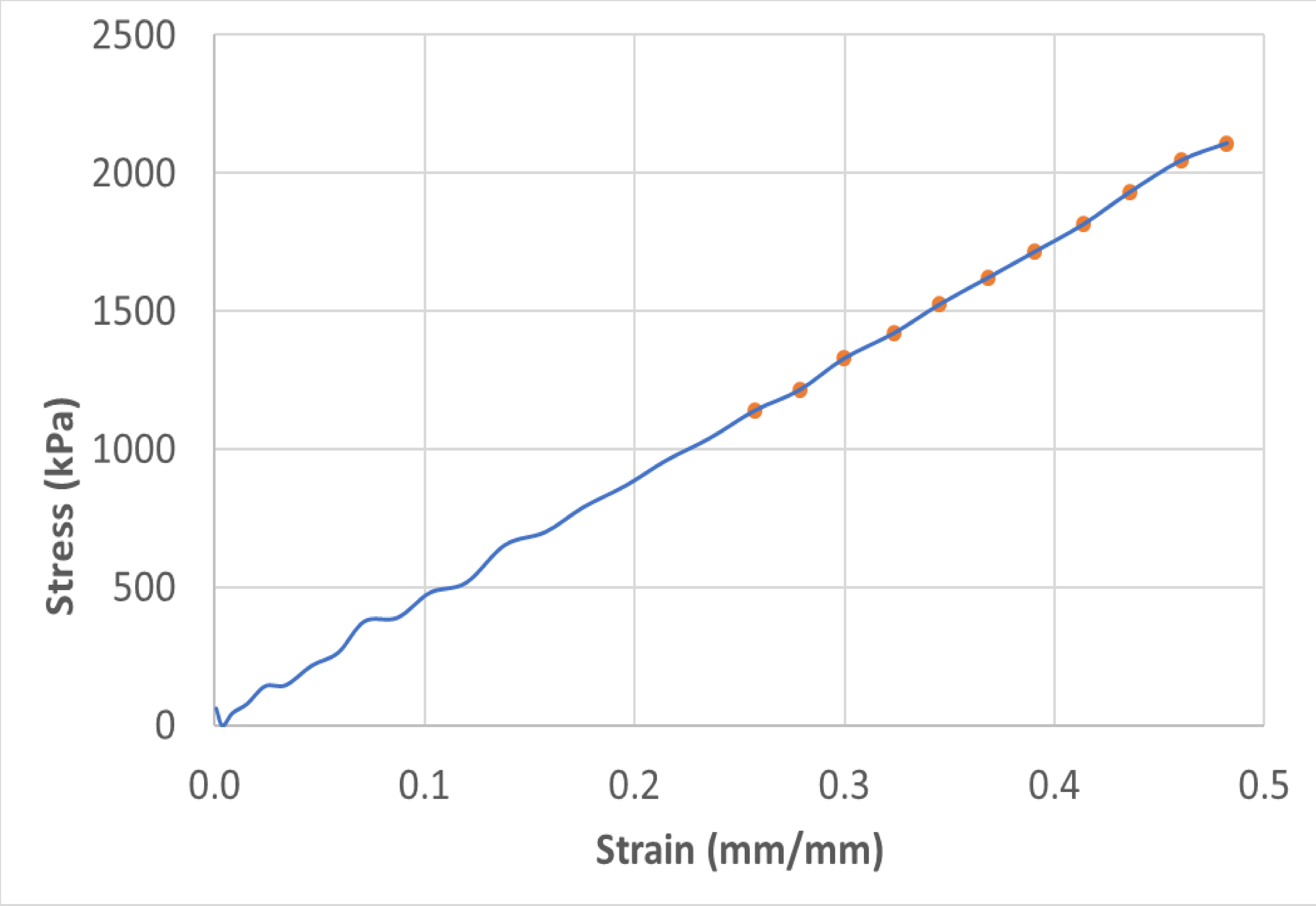


$$Strain\ (\epsilon) = \frac{L - 3000}{3000}$$

$$Stress\ (\sigma) = \frac{F_{fibre}}{Thickness\ x\ Width}$$

$$F_{fibre} = \frac{F_{beam}\ L}{\Delta d}$$

$$L = \sqrt{\Delta d^2 + 3000^2}$$



Results and Conclusions

Stress-strain plots were produced and the slope from 25-50% strain was used to calculate Young's modulus for sample in each test. The results show agreement between the 2 methods.

While both methods are valid, the 3-point method with the MicroTester has been shown to be superior for specimens smaller than 10mm long and/or peak forces less than 100mN.

E (MPa)	Uni-axial Tension	3-Point Tension
Test 1	4.4	4.4
Test 2	4.4	4.2
Test 3	4.2	4.3
Average	**4.3**	**4.3**

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