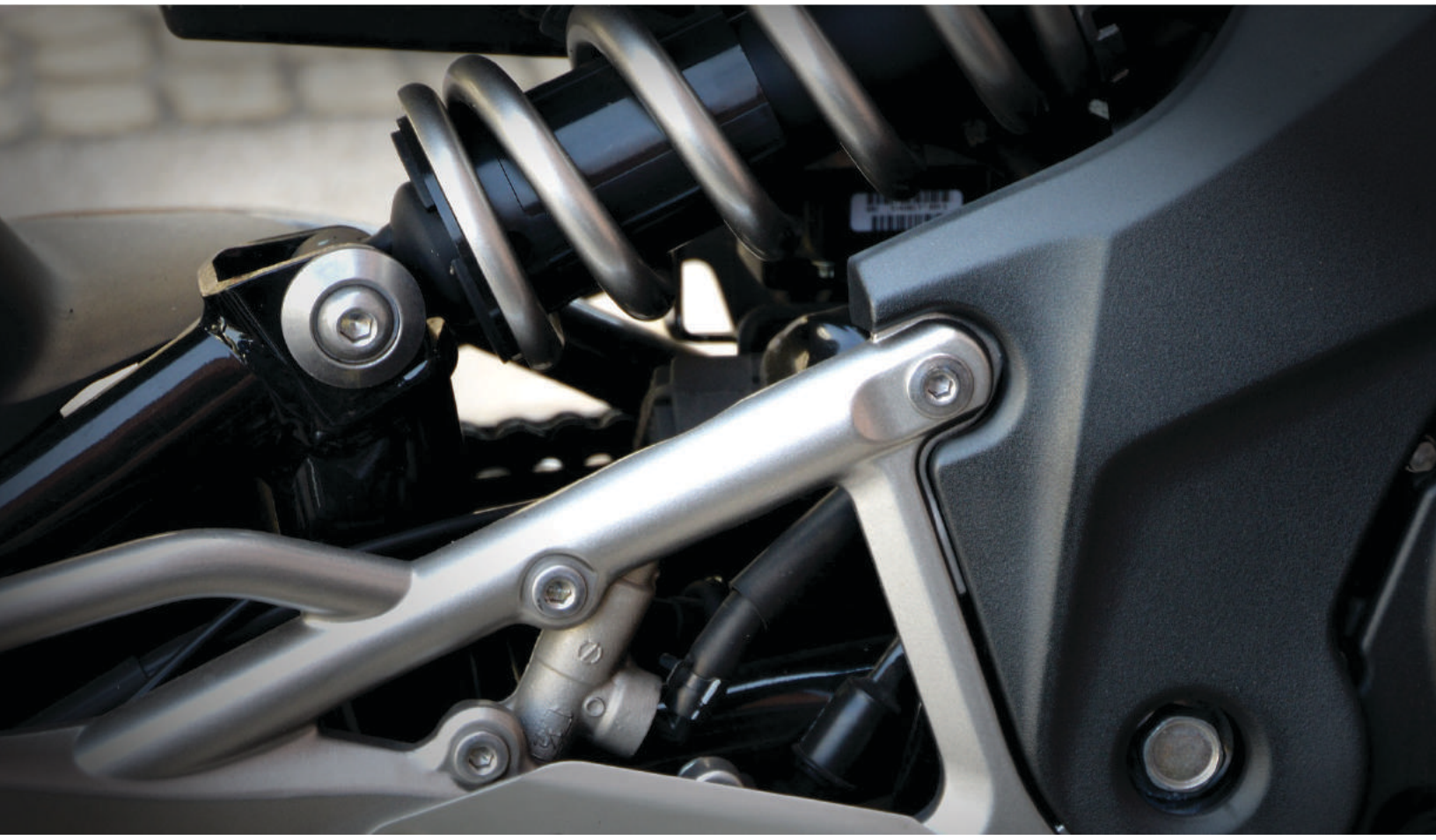
NANOVEA
A Better Measure

www.nanovea.com
info@nanovea.com
euro@nanovea.com
mexinfo@nanovea.com
(949)-461-9292

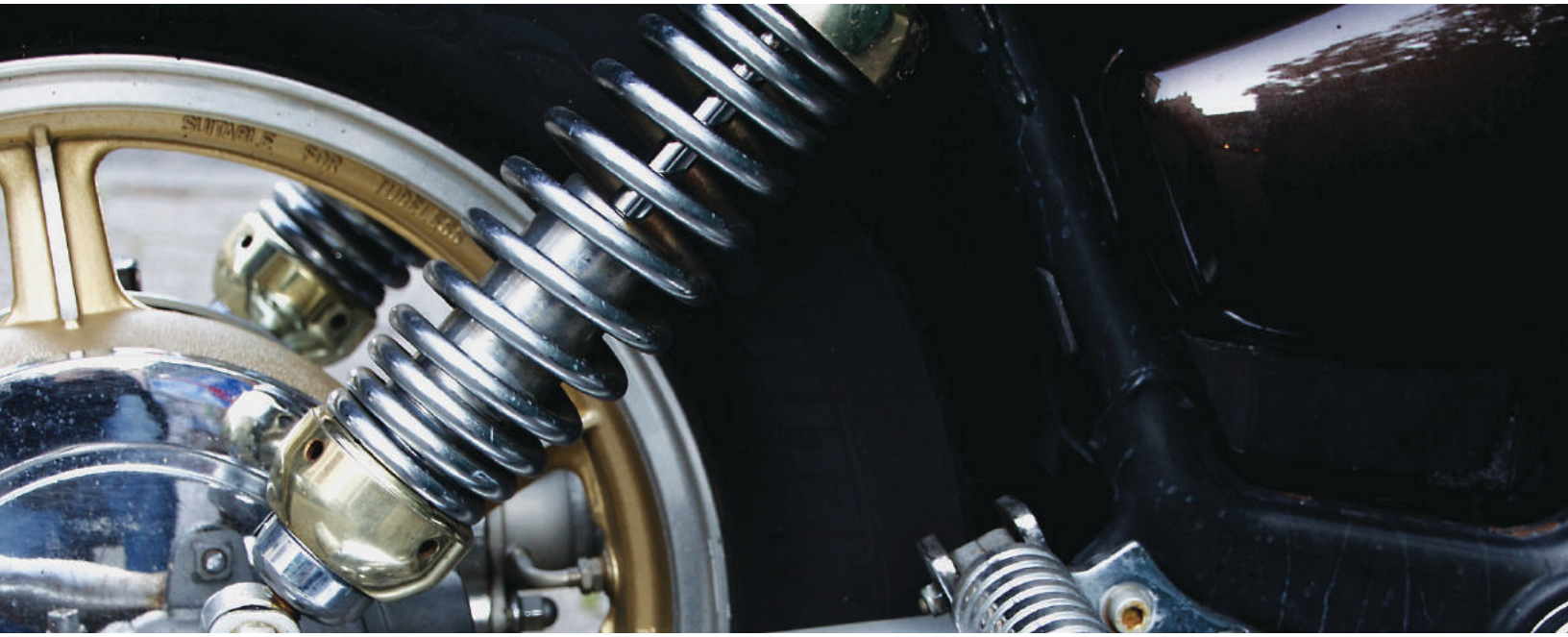
NANO MECHANICAL CHARACTERIZATION OF SPRING CONSTANTS



Prepared by

Xavier Herrera-Keehn & Jocelyn Esparza

www.nanovea.com
info@nanovea.com
euro@nanovea.com
mexinfo@nanovea.com
(949)-461-9292



INTRODUCTION

A spring's ability to store mechanical energy has a long history of use. From bows for hunting to locks for doors, spring technology has been around for many centuries. Nowadays we rely on springs, be it from mattresses, pens, or automotive suspension, as they play a vital role in our daily lives. With such a wide variety of use and designs, the ability to quantify their mechanical properties is necessary.

DETERMINING SPRING CONSTANT WITH NANOVEA'S MECHANICAL TESTER

One important mechanical property of springs is their ability to compress or stretch when a load is applied, this is quantified by the spring constant. The spring constant can be found by looking at the slope of the load vs. depth curve; a linear spring will follow Hooke's Law: $F = -kx$. Where F is the force applied, x is the springs displacement, and k is the spring constant. With the variety of modules offered with the Nanovea's Mechanical Tester, loads ranging from sub mN to 400N can be applied onto a spring. The Nanovea's Mechanical Tester can precisely record the changes in depth as it applies a load onto the spring, as well as recording a springs' deflection up to 20mm. Keep in mind as the spring constant increases, higher loads will be needed to accurately obtain the spring constant.

Measurement Objectives

Equipment Featured

NANOVEA PB1000

Multi Module Platform

3 Testing Modes in 1 (Scratch/Indent/Wear)

Loading Ranges from 0.8uN to 400N

XYZ Motion with 0.20um Step Resolution

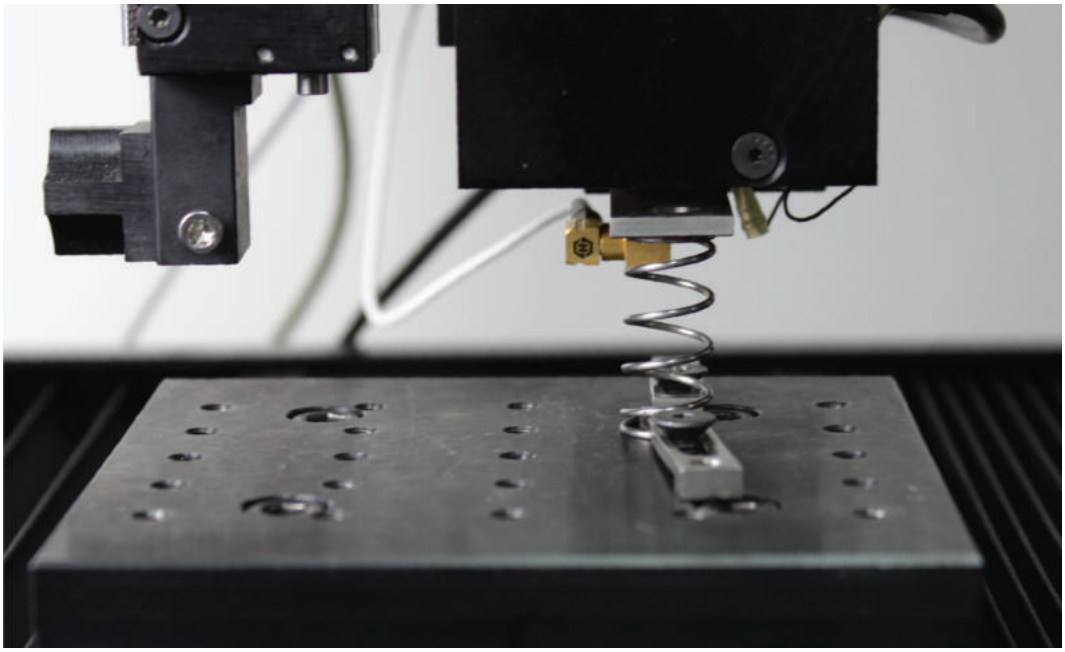
Fully Automated (Up to 100 indents in 15mins)

Integrated Imaging (AFM, Profilometer, Microscope)

Learn More about the PB1000!

Measurement Objectives

The objective of this application note is to demonstrate the versatility of the Nanovea Mechanical Tester by measuring the spring rate of three distinct coil springs with the Nano Module.



Sample being tested on Nanovea PB1000

Mechanical Testing Results

Measurement Parameters

All Samples	
Maximum Force (mN)	150
Loading Rate (mN/min)	300
Unloading Rate (mN/min)	300
Indenter Type	Flat

Table 1: Test parameters used

Samples Tested

Samples of Springs Tested

Mechanical Testing Results

Discussion

Shown below is the data for the three spring samples, three tests were performed on each spring and their respective spring constants were found. A linear trend was fitted onto the loading curve to obtain the slope, the slope being the spring constant. The R^2 value describes how well the linear trend was fitted to the dataset (1 being a perfect fit).

Spring #1	Spring Constant k (mN/μm)
Test 1	0.9358
Test 2	0.9319
Test 3	0.9344
Average	0.9340
Standard Deviation	.001613

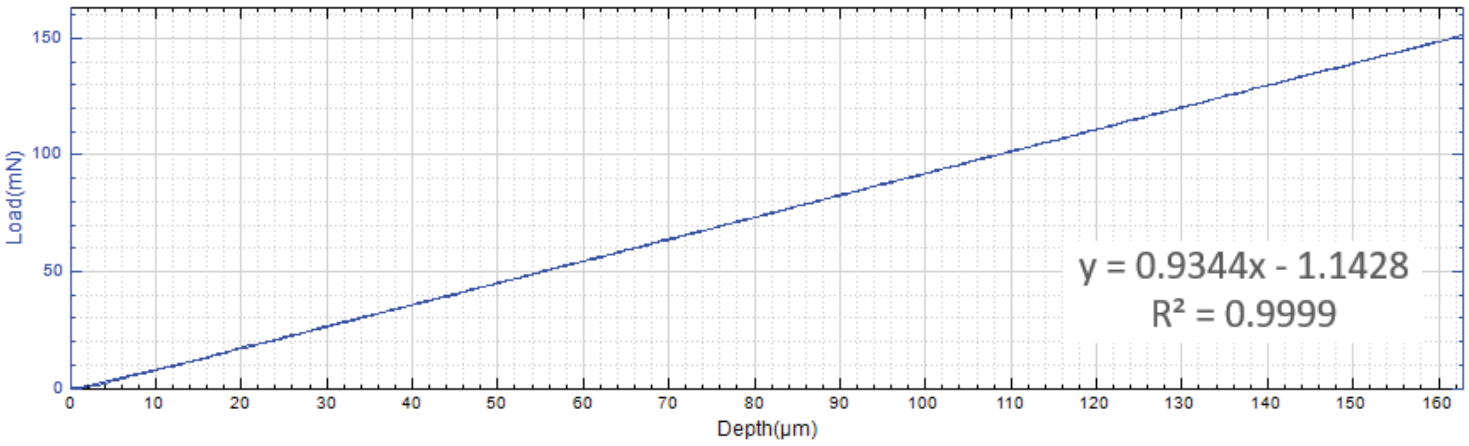


Figure 1: Load vs Depth for Spring 1 Test 3

Discussion

Spring #2	Spring Constant k (mN/µm)
Test 1	1.5057
Test 2	1.5149
Test 3	1.5224
Average	1.5143
Standard Deviation	0.00683

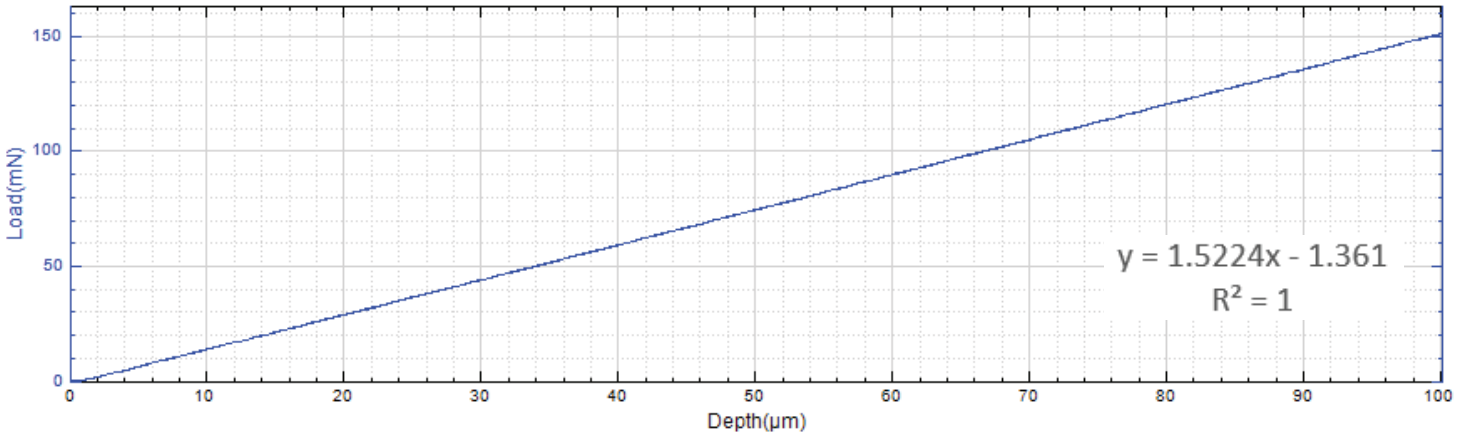


Figure 2: Load vs Depth for Spring 2 Test 3

Discussion

Spring #3	Spring Constant k (mN/µm)
Test 1	2.2293
Test 2	2.2518
Test 3	2.2396
Average	2.2402
Standard Deviation	0.009196

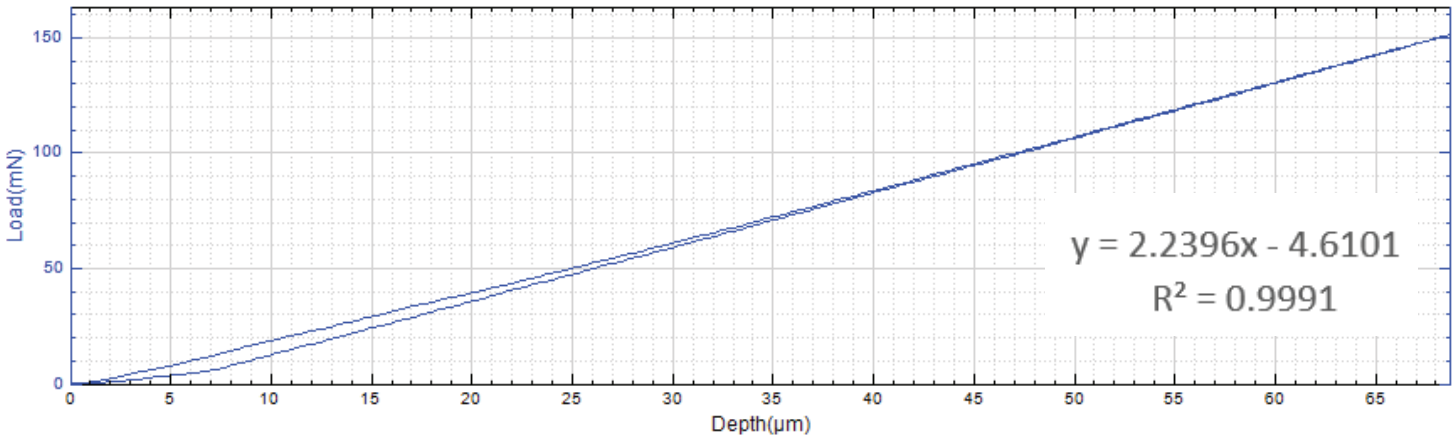
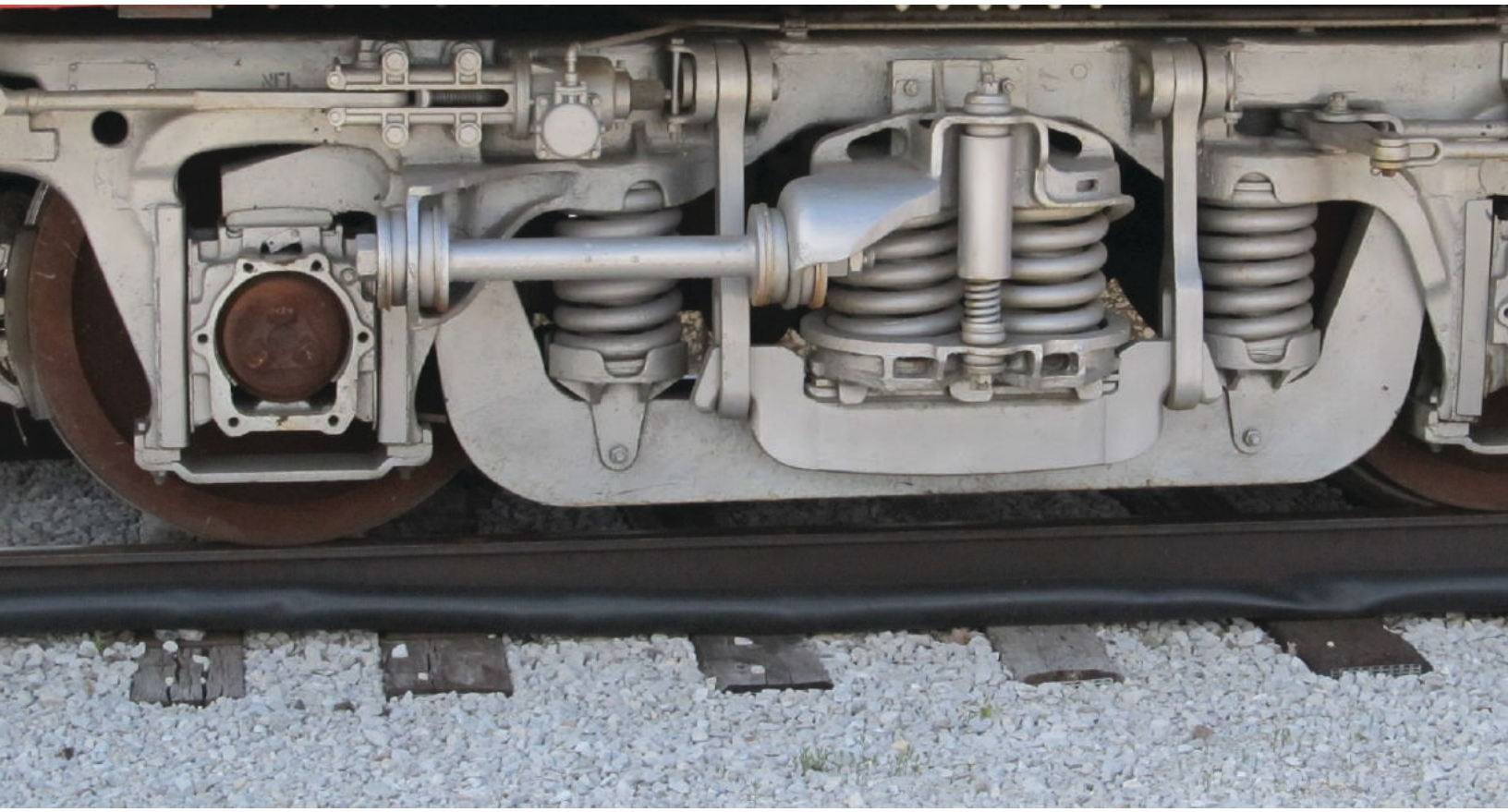


Figure 3: Load vs Depth for Spring 3 Test 3

As you can see, the data for each of the three coil springs is repeatable and consistent. With the highest standard deviation being 0.009196 mN/µm for the third spring, but this is to be expected as the spring constant becomes greater.

www.nanovea.com
info@nanovea.com
euroinfo@nanovea.com
mexinfo@nanovea.com
+1 (949) 461-9292



Conclusion

Since springs are used in many different industries, quantifying their mechanical energy is necessary. In this study we were able to accurately and precisely measure the spring constant for 3 different coil springs. With the large variety of modules offered with the PB1000 Nanovea Mechanical Tester, spring deflection up to 20mm can be recorded.

Check out our full application notes library!