Compression Pads; Thermo-mechanical Characterization at Sub-ambient Temperatures

SAND2016-1044PE

Mark Stavig, Patricia Sawyer,
Adam Cook, James Hochrein, and Robert Bernstein

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

National Nuclear Security Administration

Purpose

It is known that there is a low temperature thermal transition of the SE1700 material.

Question: How does this transition influence the performance of the SE1700 when functioning as a compression pad?

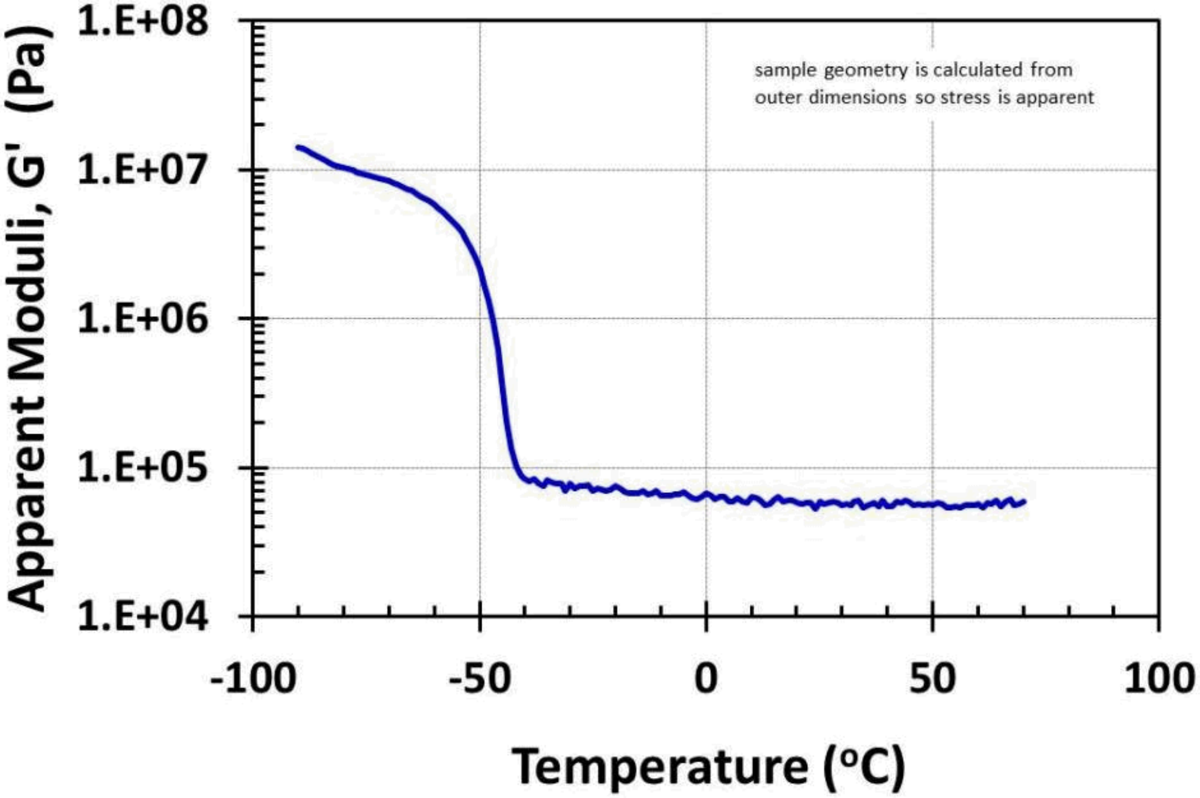
Background

> **“For most uses, silicone elastomers should be operational over a temperature range of -45 to 200°C (- 49 to 392°F) for long periods of time. However, at both the low- and high temperature ends of the spectrum, behavior of the materials and performance in particular applications can become more complex and require additional considerations. For low-temperature performance, thermal cycling to conditions such as -55°C (-67°F) may be possible, but performance should be verified for your parts or assemblies.”**

Based on SNL DMA data, there is a low temperature thermal transition ~ -40 °C (vide infra)

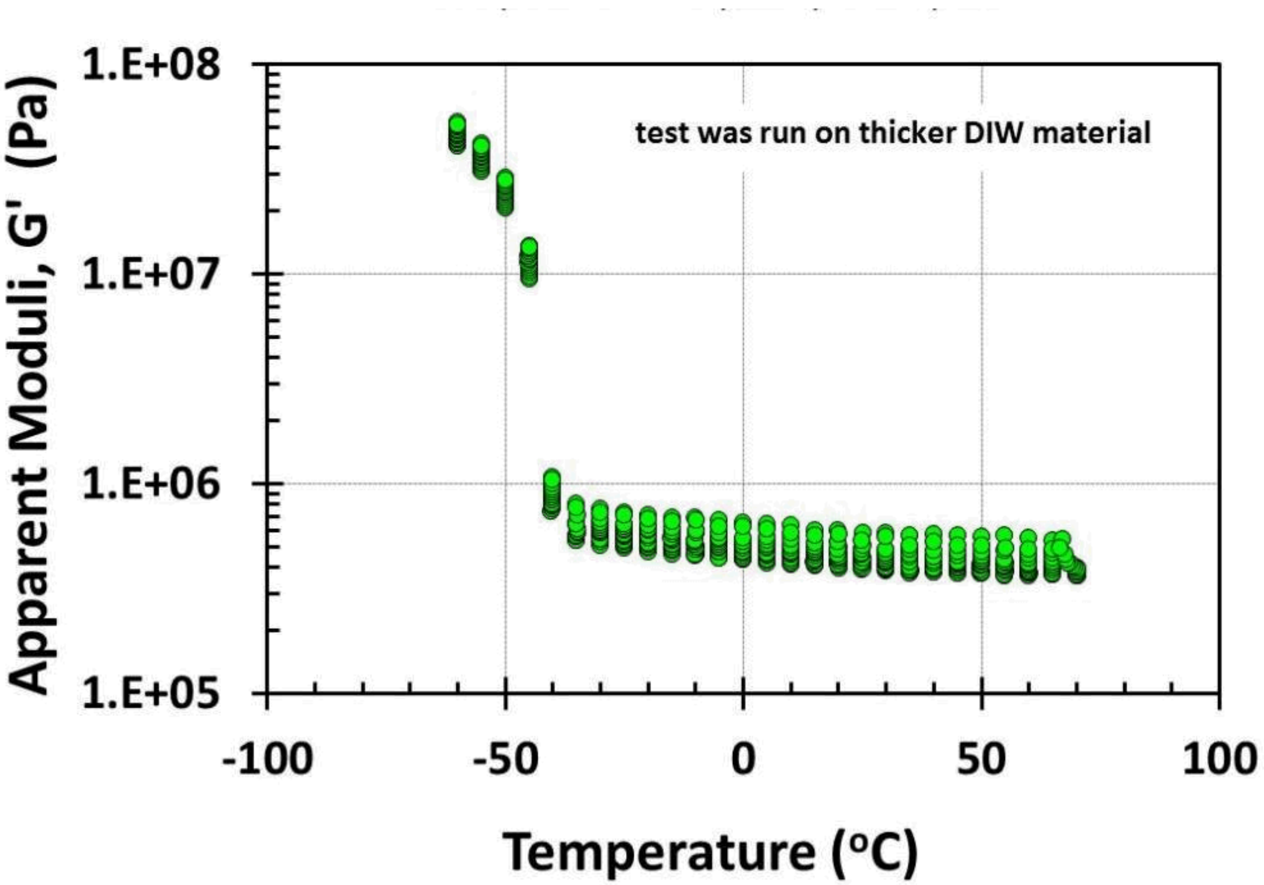
Product Information, Adhesives, SE 1700 Clear & White Adhesive; Corning, D., Ed.; Dow Corning, 2010

Old Data ~2014 1st Gen NSC Pads: DMA Testing- Initial Testing



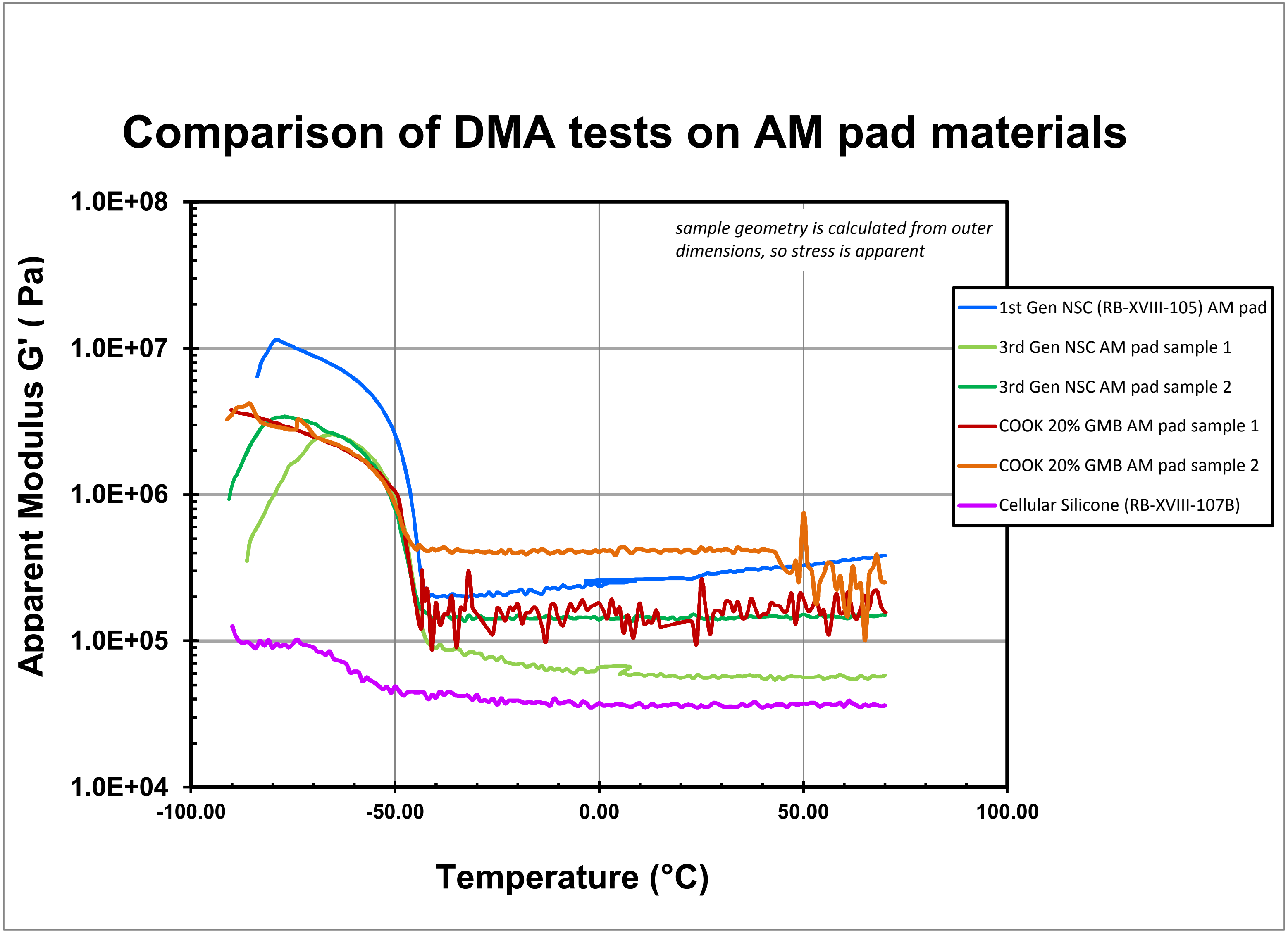
Plot showing modulus (apparent) vs. temperature. There is large drop in modulus at ~-55C.

Old Data ~2014 1st Gen NSC Pads: DMA Testing- Initial Testing



Plot showing effect of frequency at different temperatures

New Data -2016



Materials Examined

--Nominal values thickness--

…there is significant variation

NSC 3rd Gen SE1700 AM Pad (~103 mils)

Cook -20% GMB pad (~103 mils)

Cellular Silicone pads (~146 mils) (RB-XVIII-107B)

Two compression states examined: 25% or 50%

Each sample measured before testing, and that value was used to calculate gap size

Test Method

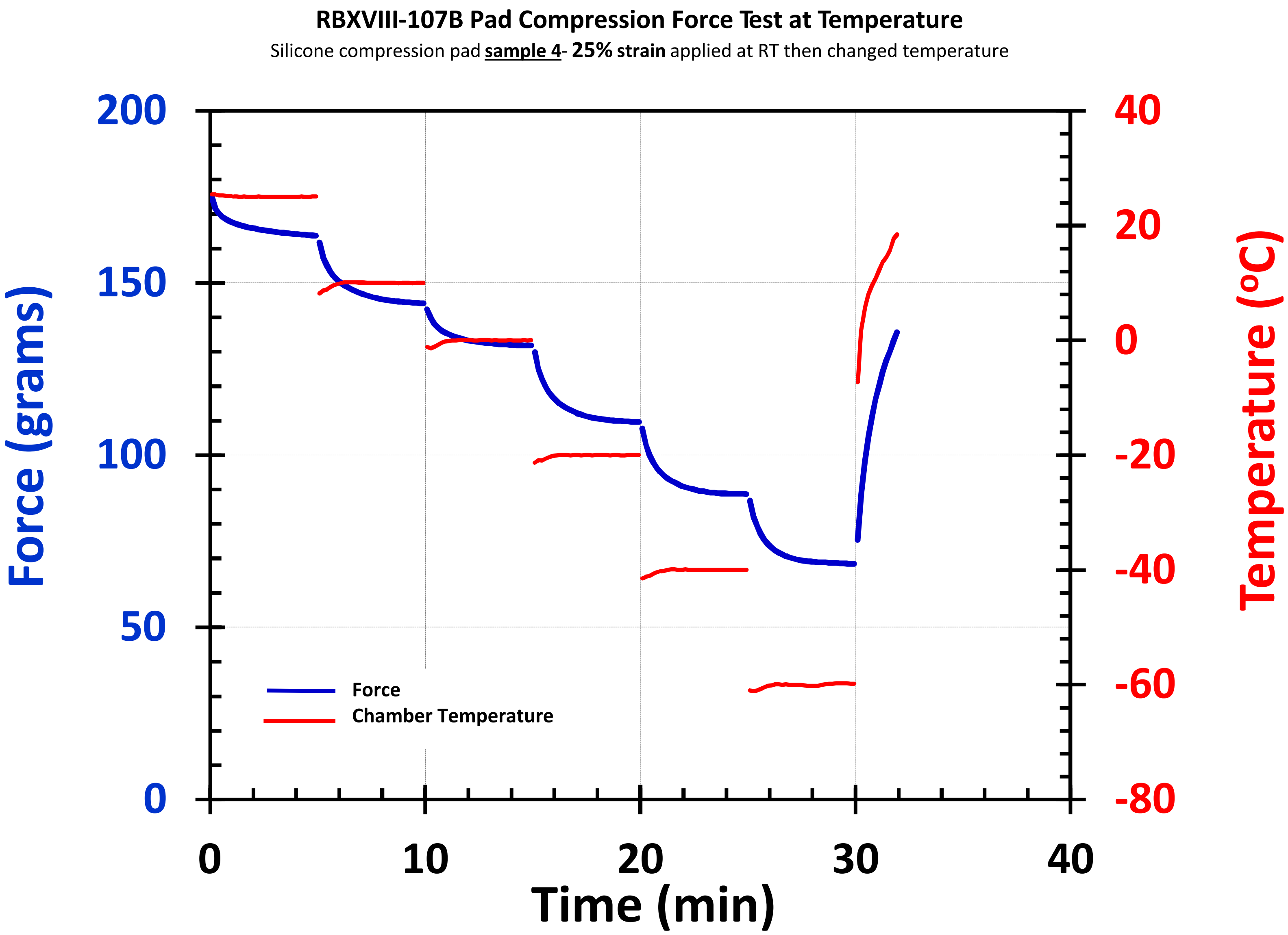
Samples compressed to nominally 25% and 50% at room temperature

Gap size held constant* and force measured as a function of temperature

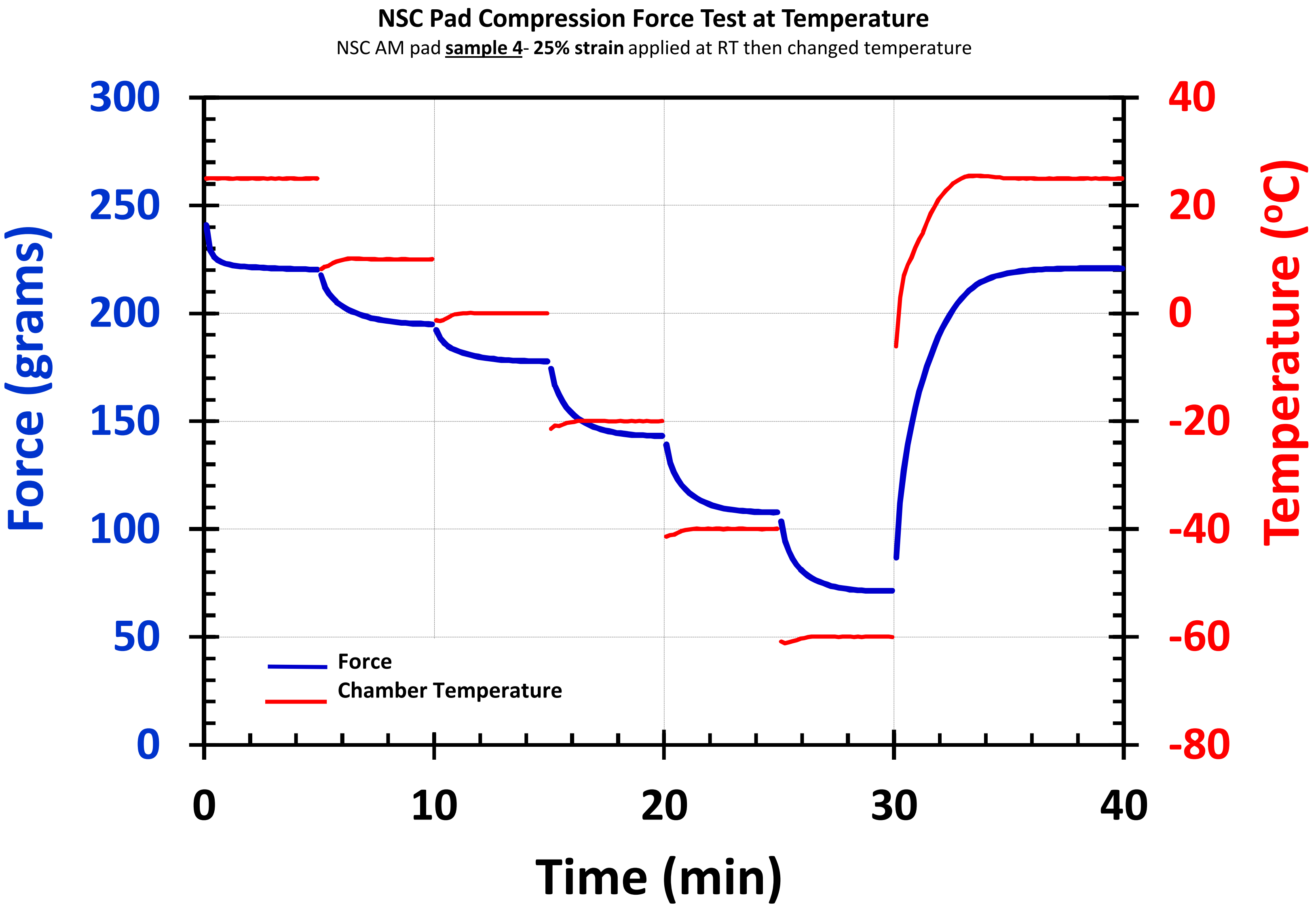
Experimental Details: TA Instruments DMA RSA-G2, hold times for 300 seconds per temperature, fixed gap size, 0.75 inch diameter samples.

***It did change because of fixturing CTE. This is on the order of 2.6um/C, so only ~260um for -60C in the direction that would decrease the force (make gap larger).**

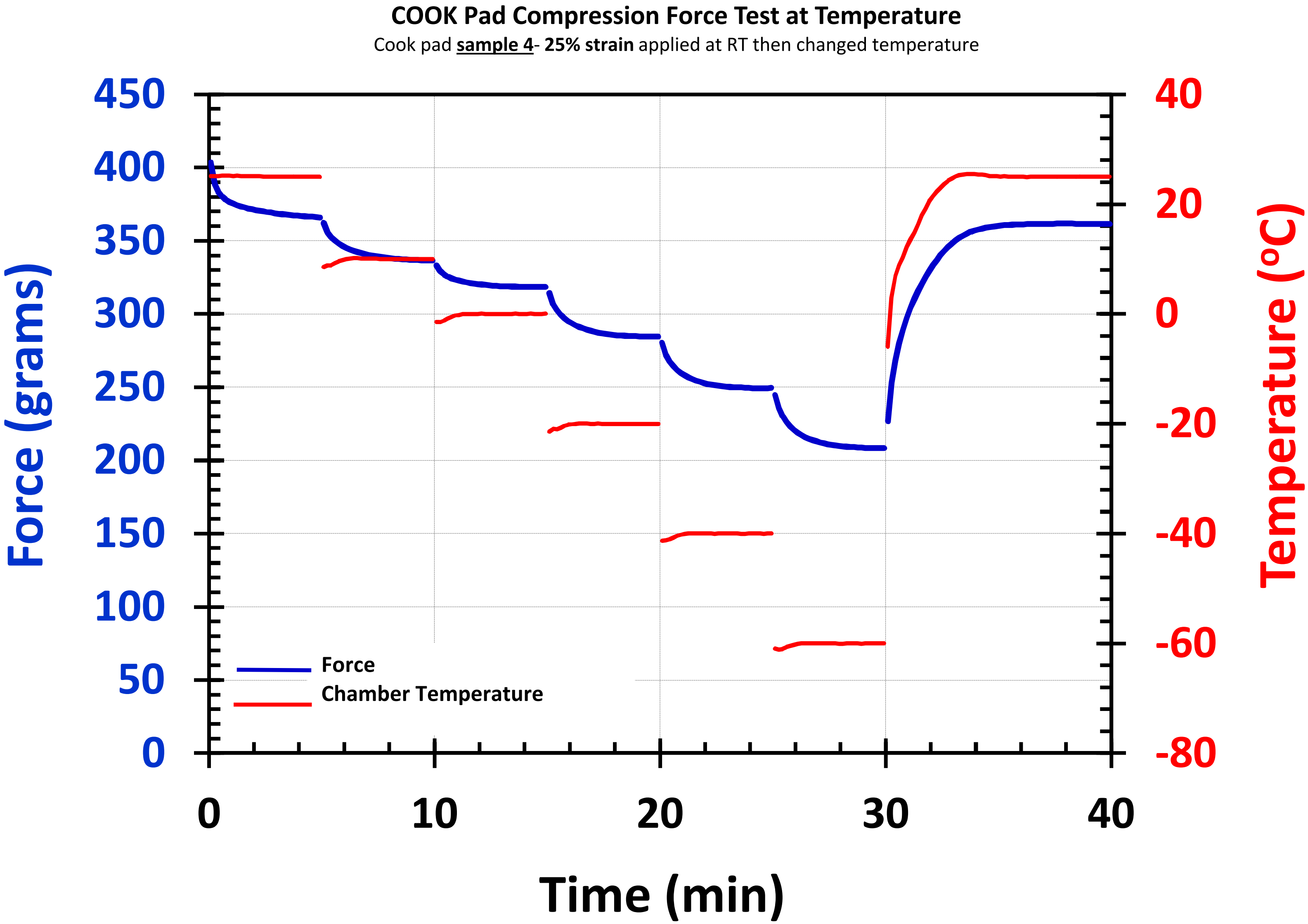
Cellular Silicone -25% Compression



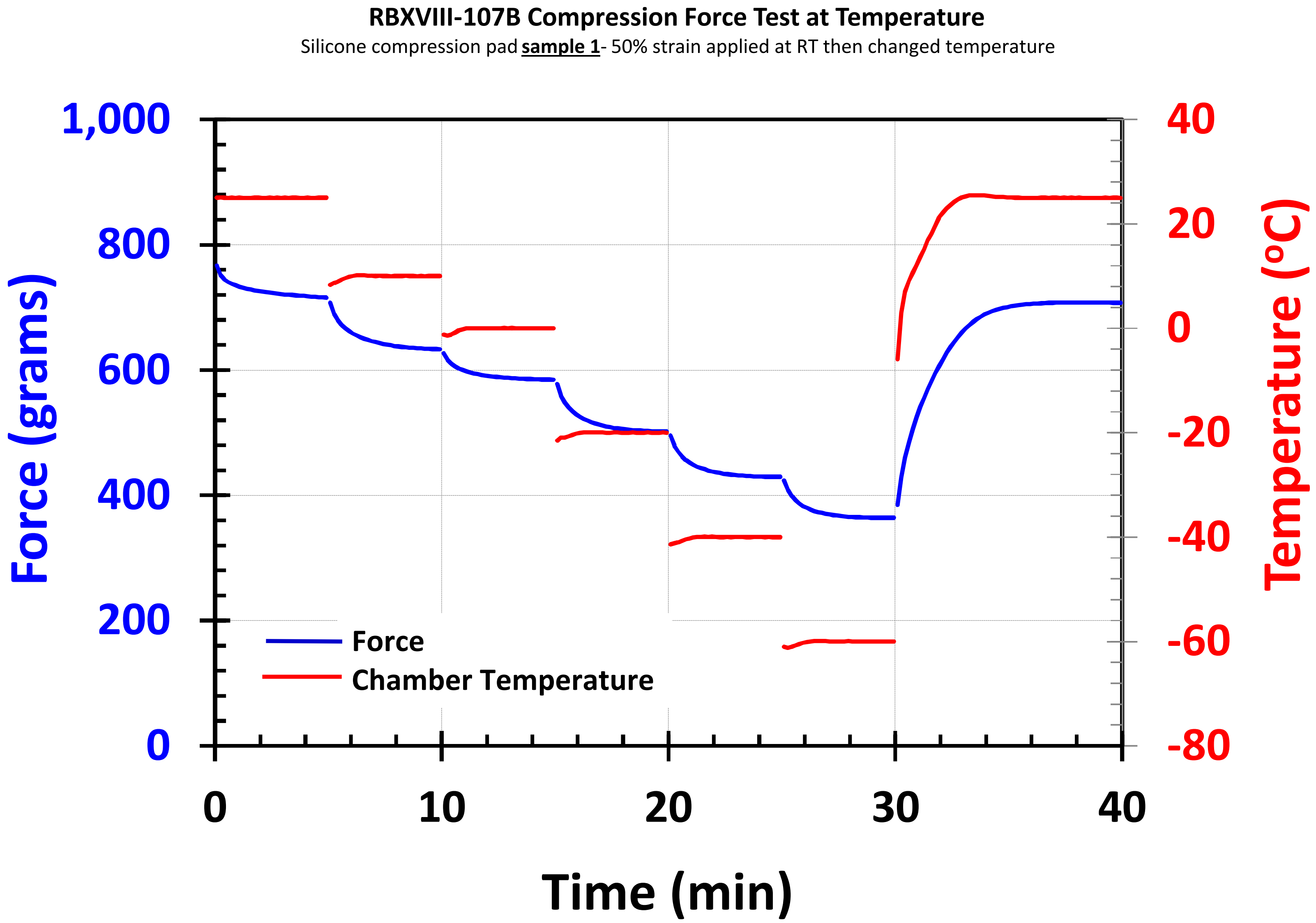
NSC 3rd Gen AM Pads -25% Compression



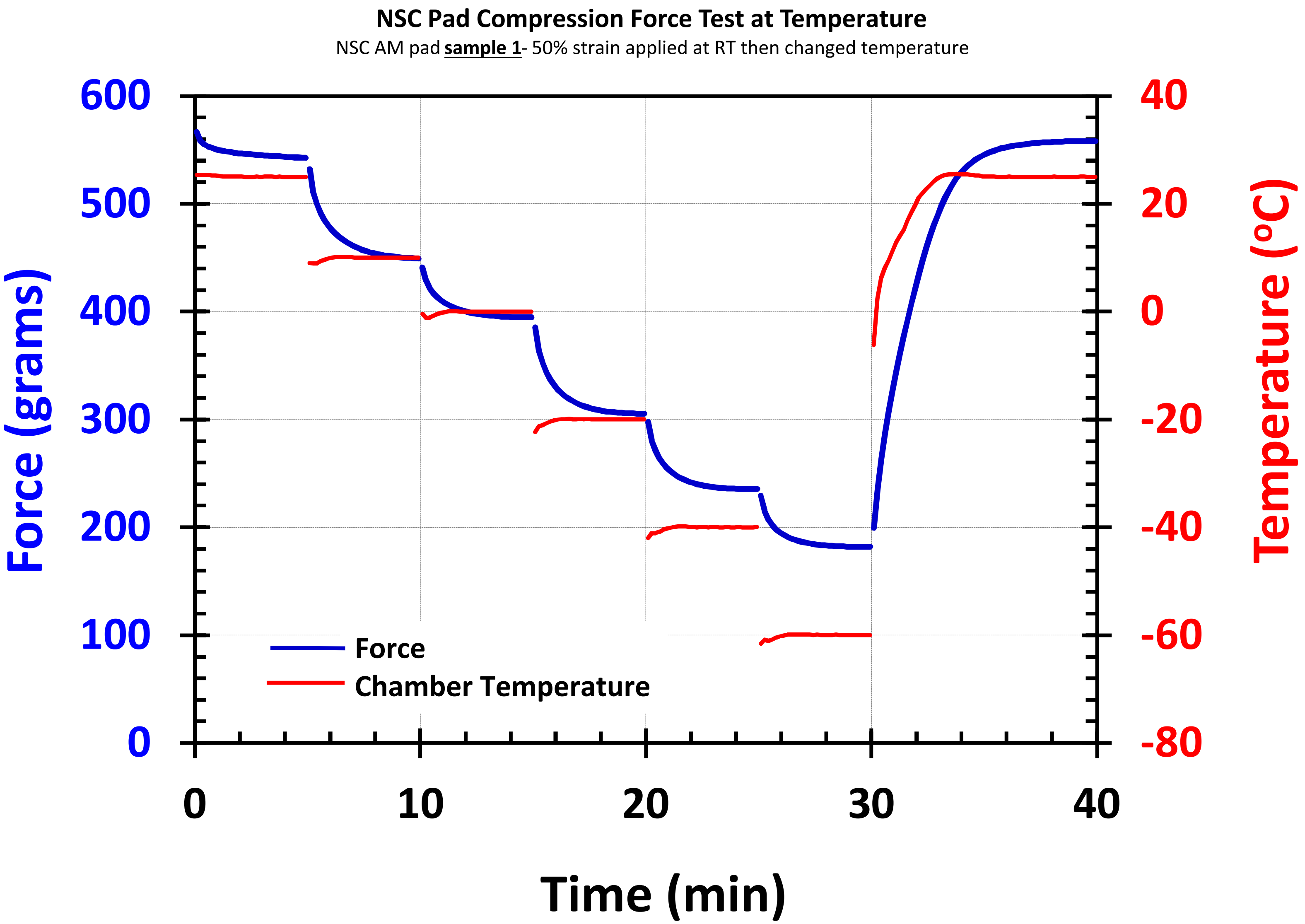
Cook 20% GMB AM Pads -25% Compression



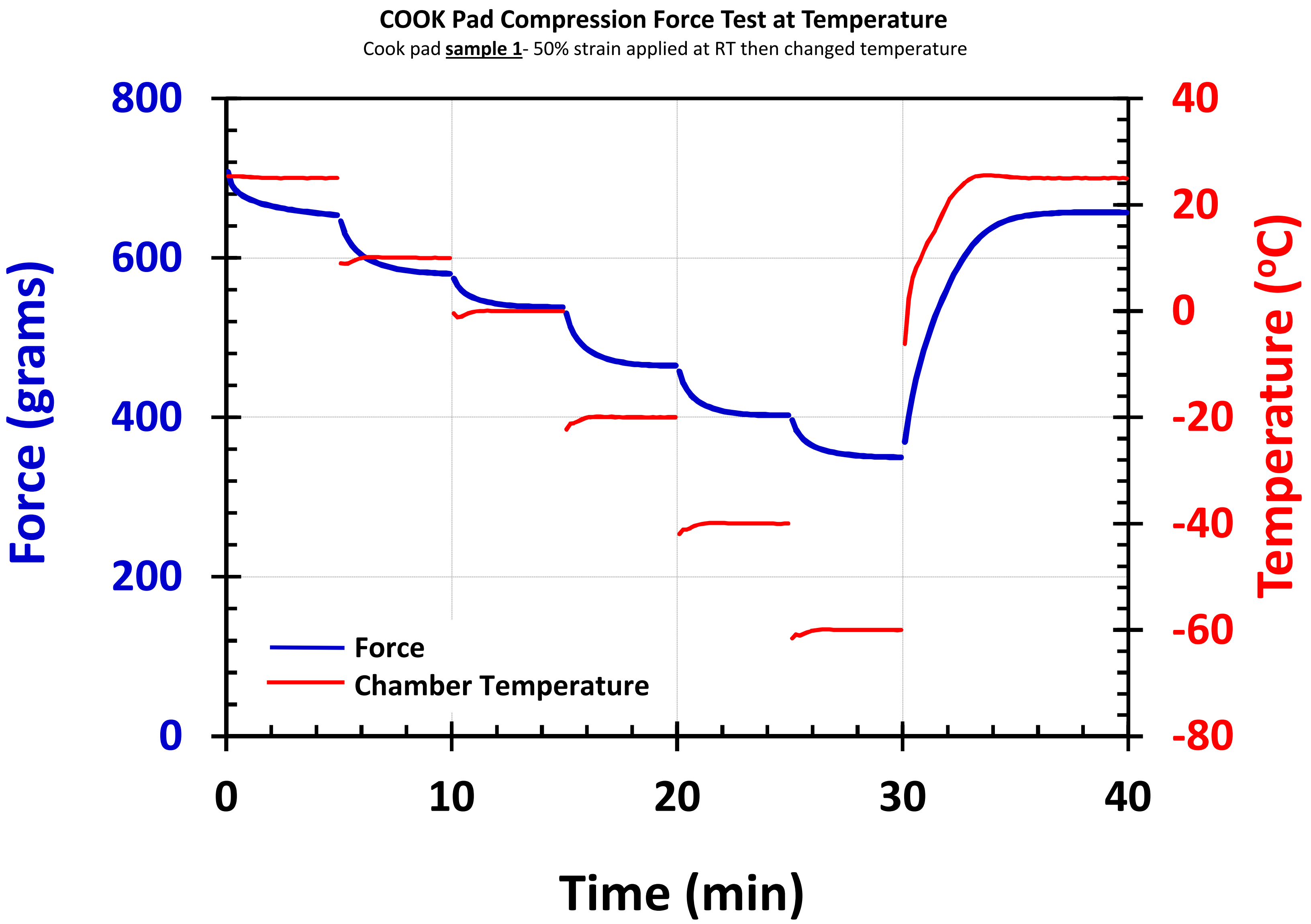
Cellular Silicone -50% Compression



NSC 3rd Gen AM Pads -50% Compression



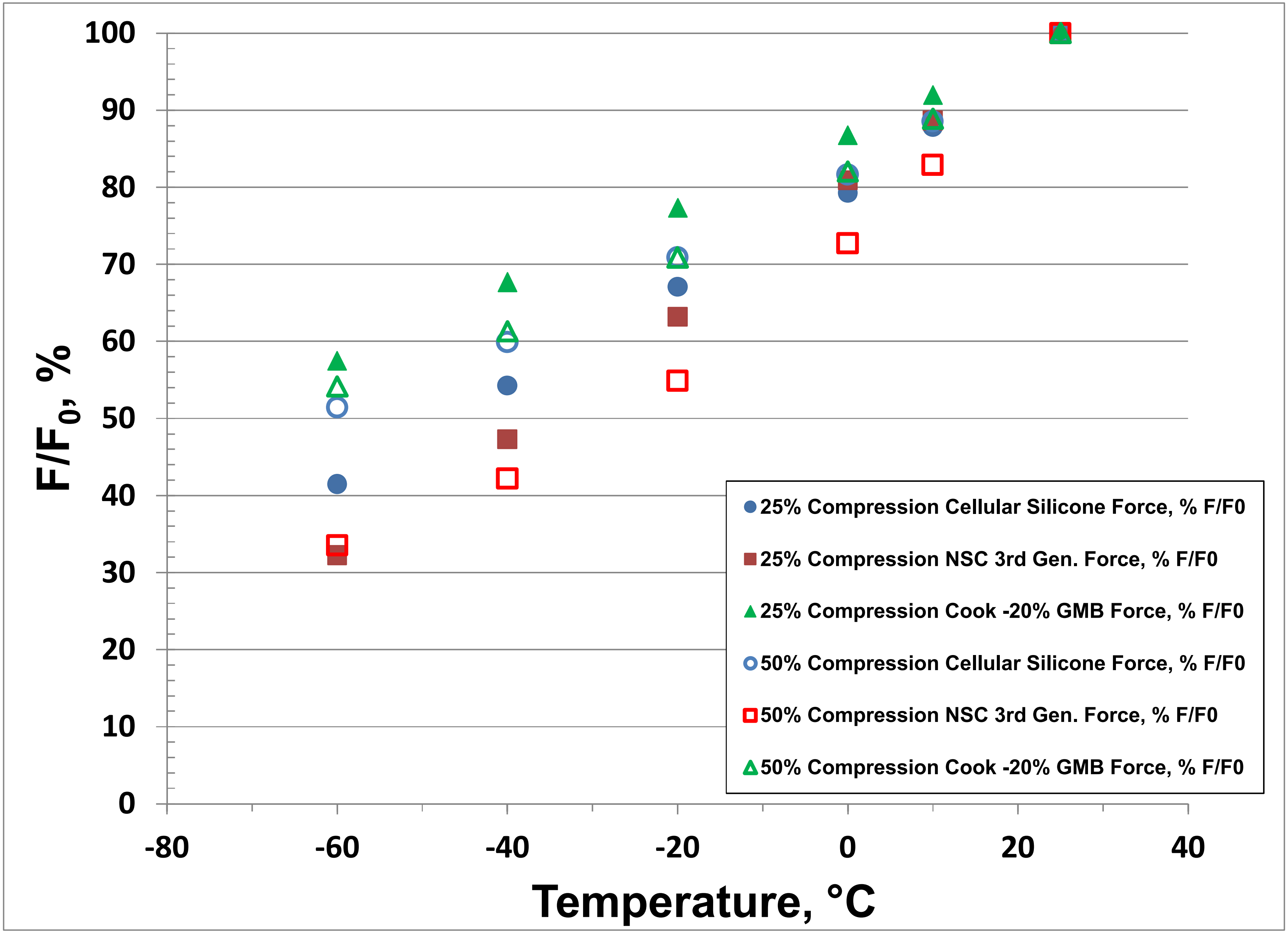
Cook 20% GMB AM Pads -50% Compression



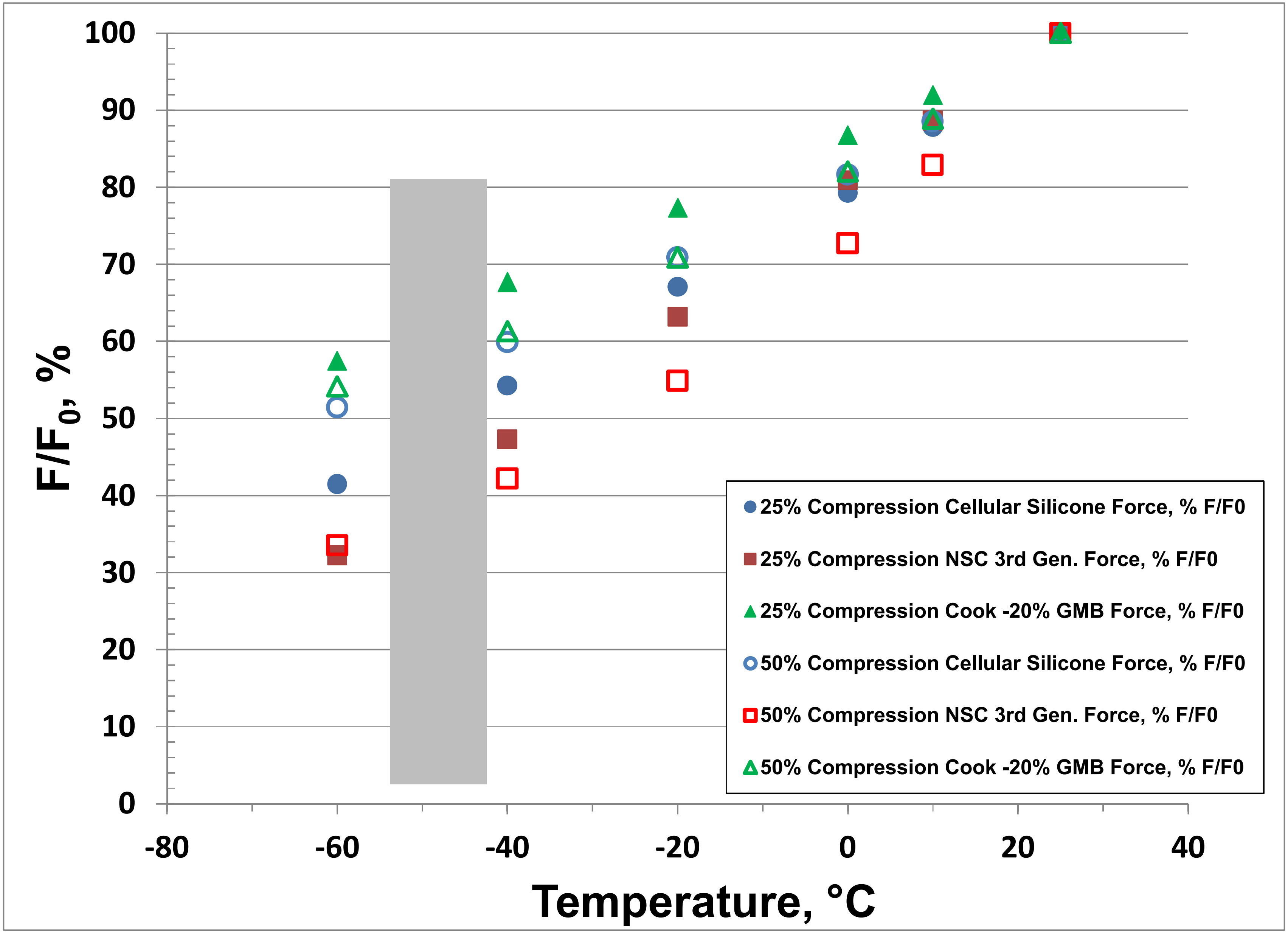
Data Analysis

Looking at data sets from above in a different way….

% Change in Force vs Temperature



% Change in Force vs Temperature



Conclusion

Low temperature thermal transition has little to no influence on static sealing for SE1700

CTE issues are likely the most influential cause for force change

Possible Future Work

Measure CTE of materials

Correlate CTE to measured force

Explore loading of GMB material and the influence on CTE and/or Force

Understand dynamic sealing

Repeat studies at elevated (above ambient) temperatures

End

Extra slides

Raw Numbers-25% Compression

Pad Type/Source	Thickness, mm	Compressed thickness, mm			
Cellular Silicone Thick	3.798	2.849			
NSC -3rd Gen	2.612	1.959			
Cook -20% GMB	2.719	2.025			

Raw Numbers -50% Compression

Pad Type/Source	Thickness, mm	Compressed thickness, mm			
Cellular Silicone Thick	4.003	2.00			
NSC -3rd Gen	2.620	1.31			
Cook -20% GMB	2.702	1.35			