

DEVELOPING A FRAMEWORK FOR ESTIMATING THE MATERIAL OPERATING LIMIT OF EPOXY RESINS

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Introduction

- Composites are popular for armor usage due to their specific strength and flexibility in areas of use
- Composites can withstand both quasi-static loads and high-velocity impacts
- Epoxy resins significantly affect the composite performance

Problem Specification

- Current epoxy resin, SC-15, used in durable armor applications has a $T_g \sim$ of 85 C (mid-point DSC)
- To achieve better performance, a framework of testing methodology is being developed to test a new epoxy-resin, RDL-RDC, to quantify the difference in both epoxy resins and estimate Material Operating Limit

Methodology

- Resin molded between glass panels and Teflon spacers
- Cylindrical specimens core drilled
- Samples conditioned in Tenney environmental chamber at 76C 88%RH
- Periodic weight measurements for moisture uptake
- Control batch left unconditioned, in desiccator

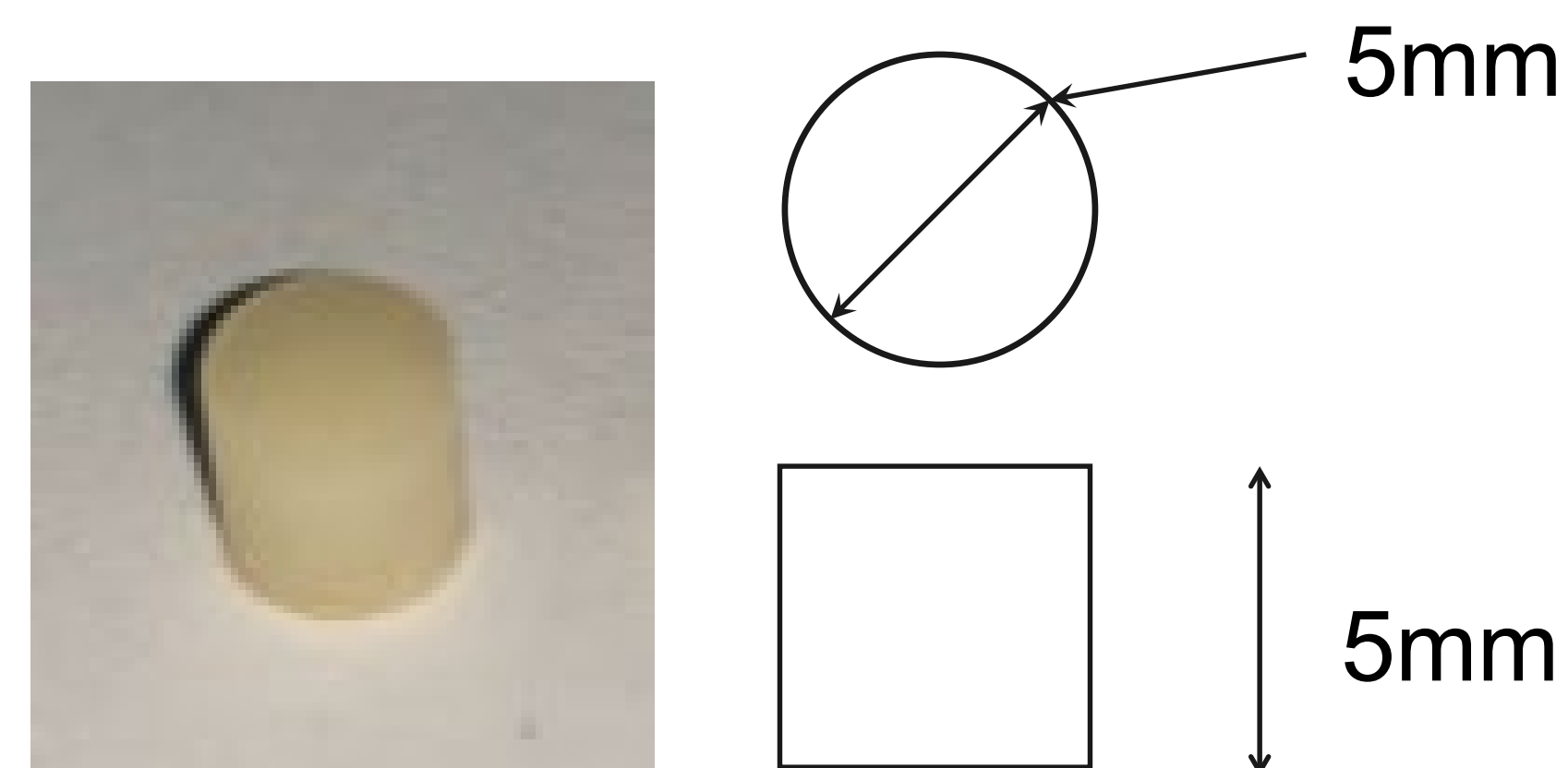


Figure 1: Epoxy resin compression sample size

- Using an Instron, compression testing of cylindrical samples ran at multiple strain rates and 4-6 temperatures

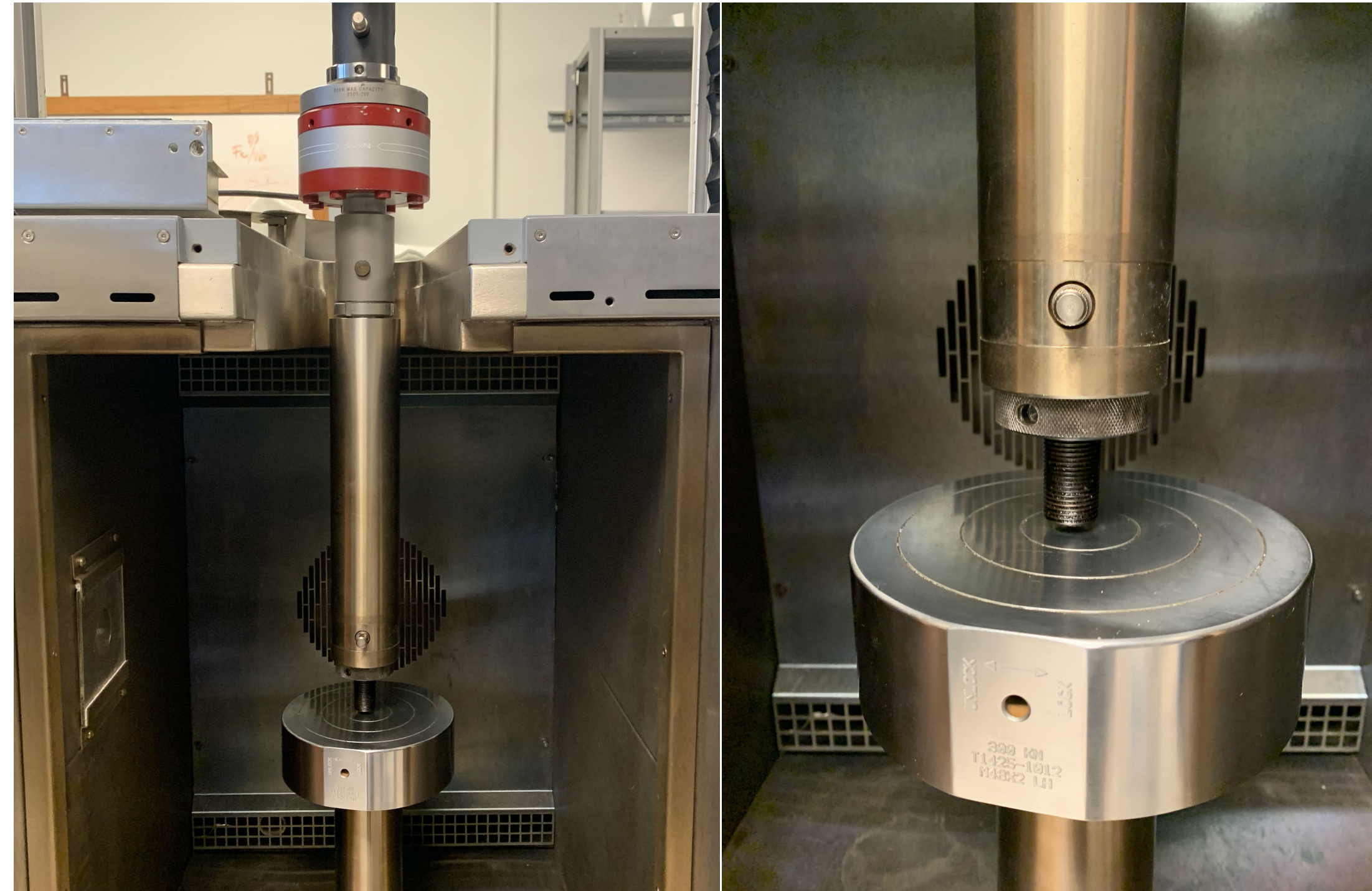


Figure 2: Instron set up for compression testing incl. oven

Results and Discussion

- RDL-RDC has a higher T_g of \sim 125C (lower when conditioned), making the mechanical properties more resistance to temperature
- Weight gain from samples increased by 2-2.5%

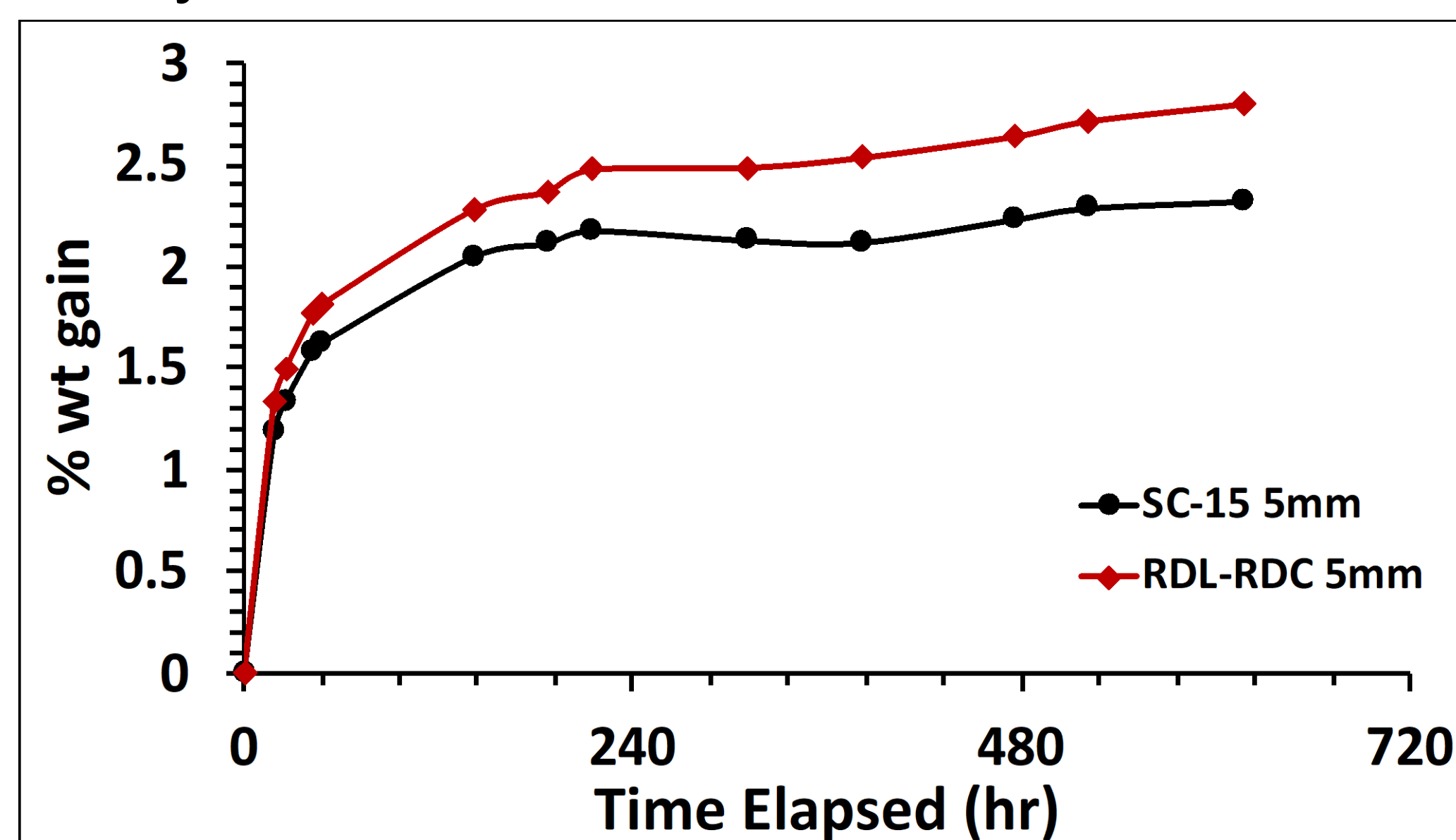


Figure 3: Moisture intake for the sample over time

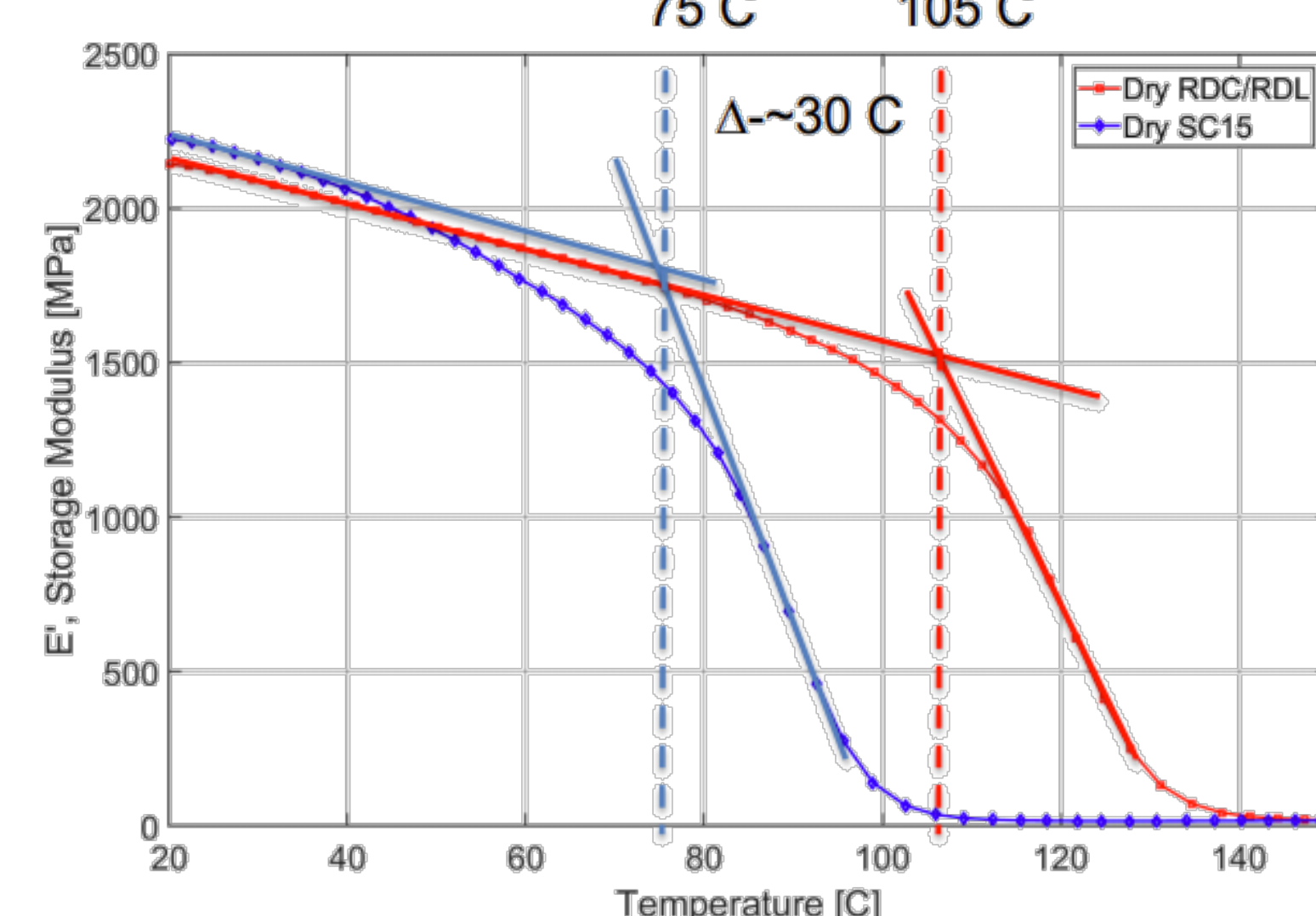


Figure 4: DMA mid point T_g results

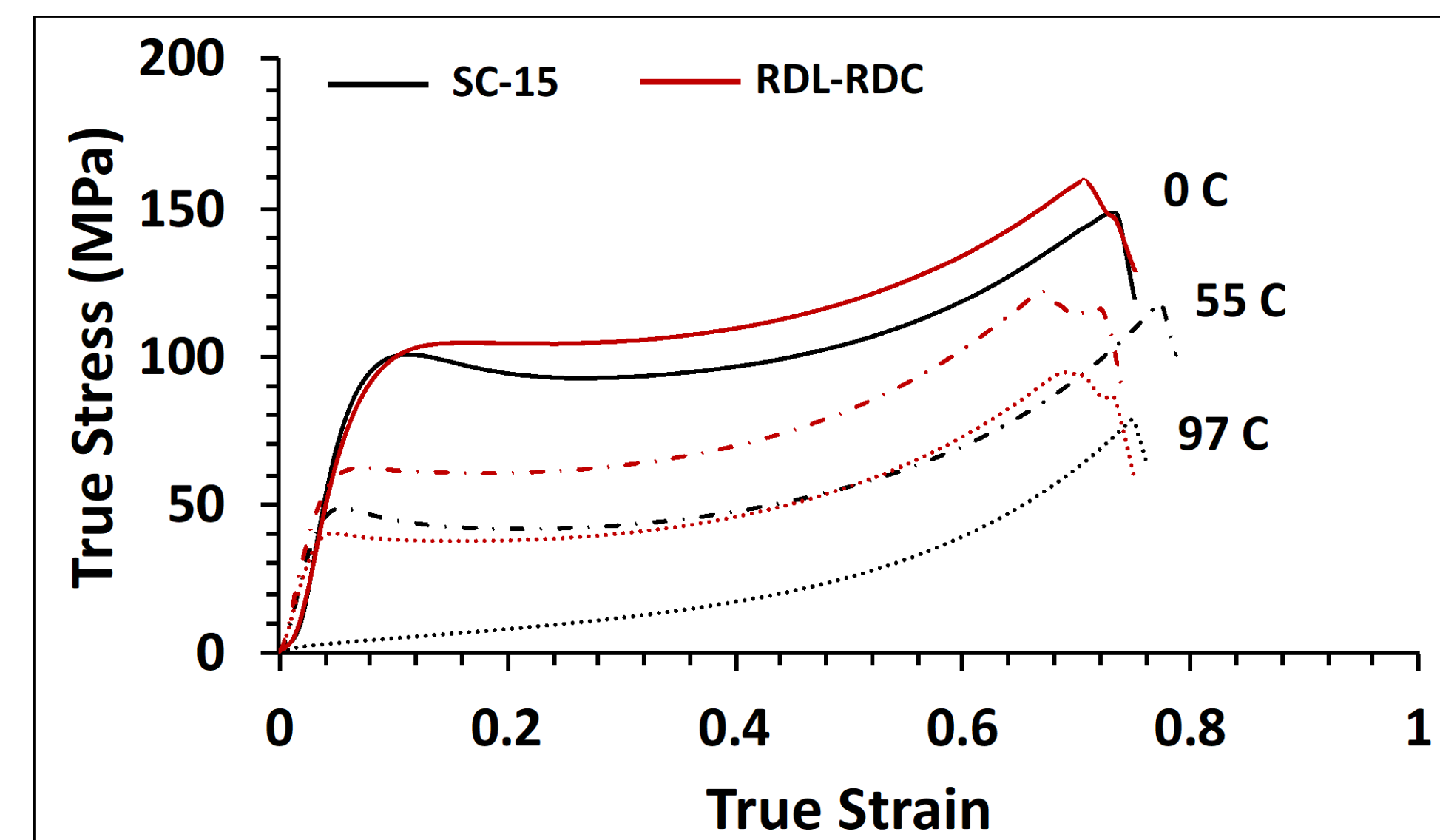


Figure 5: Stress strain curve for resins across ranging temps

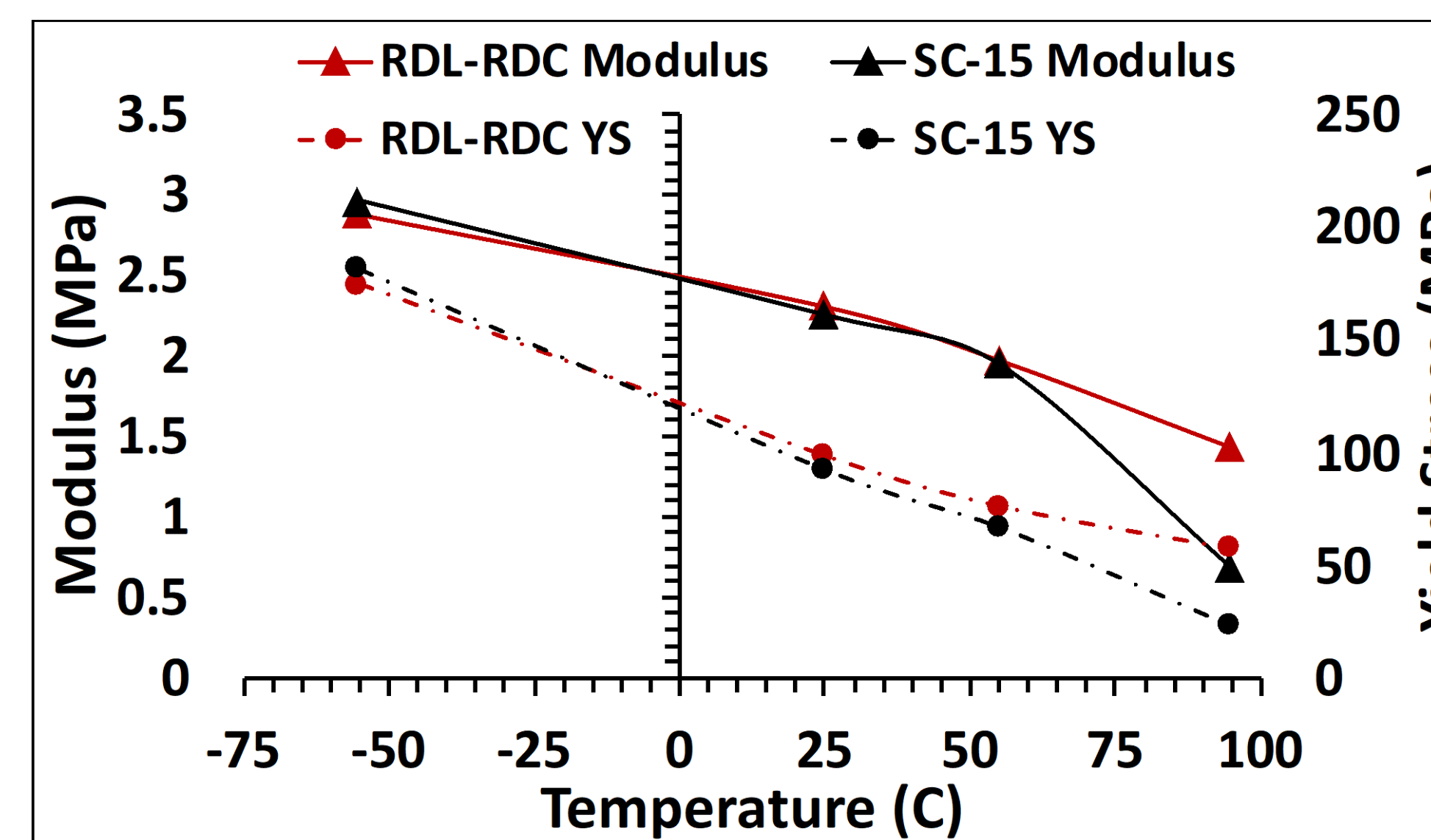
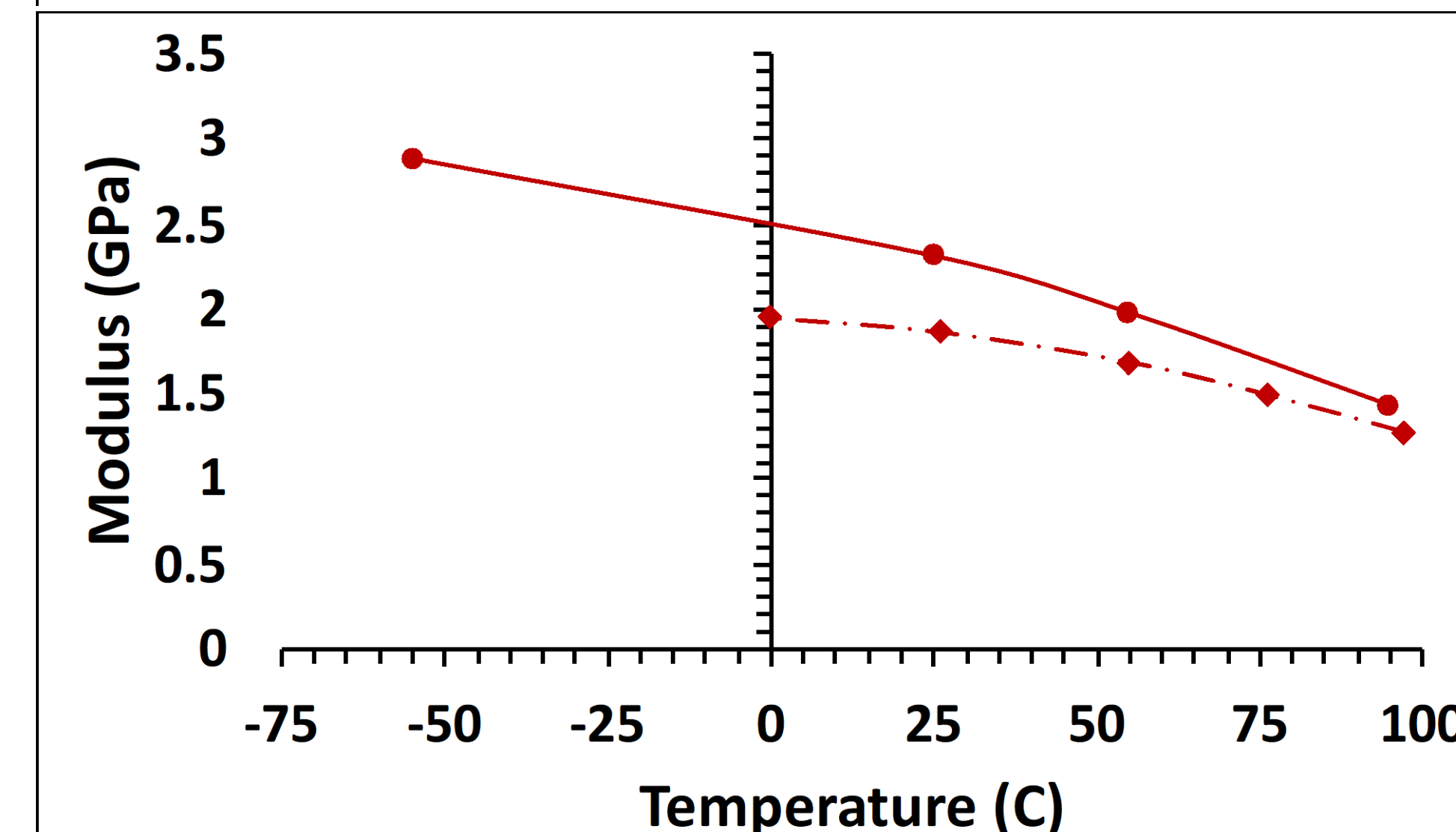
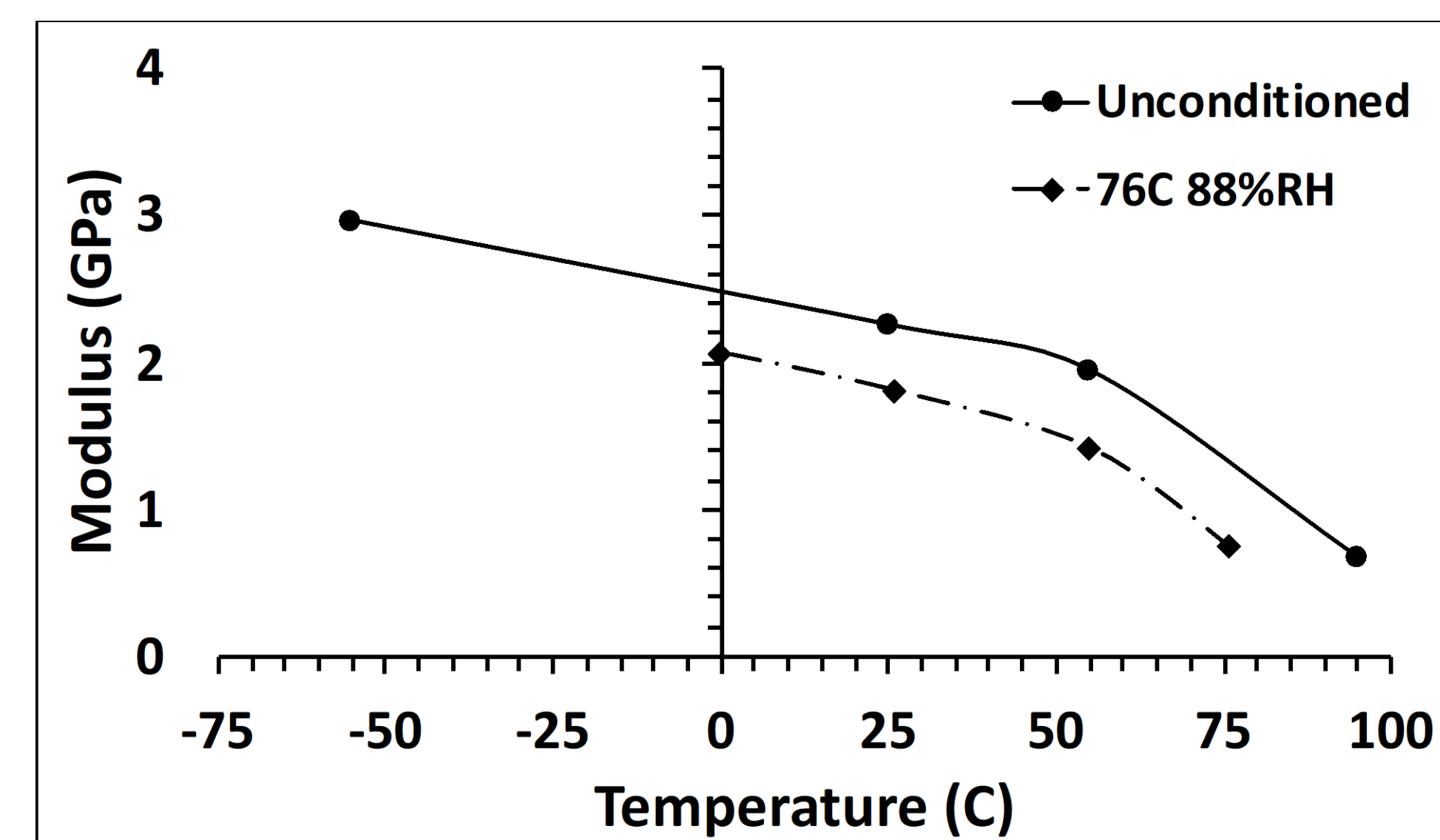
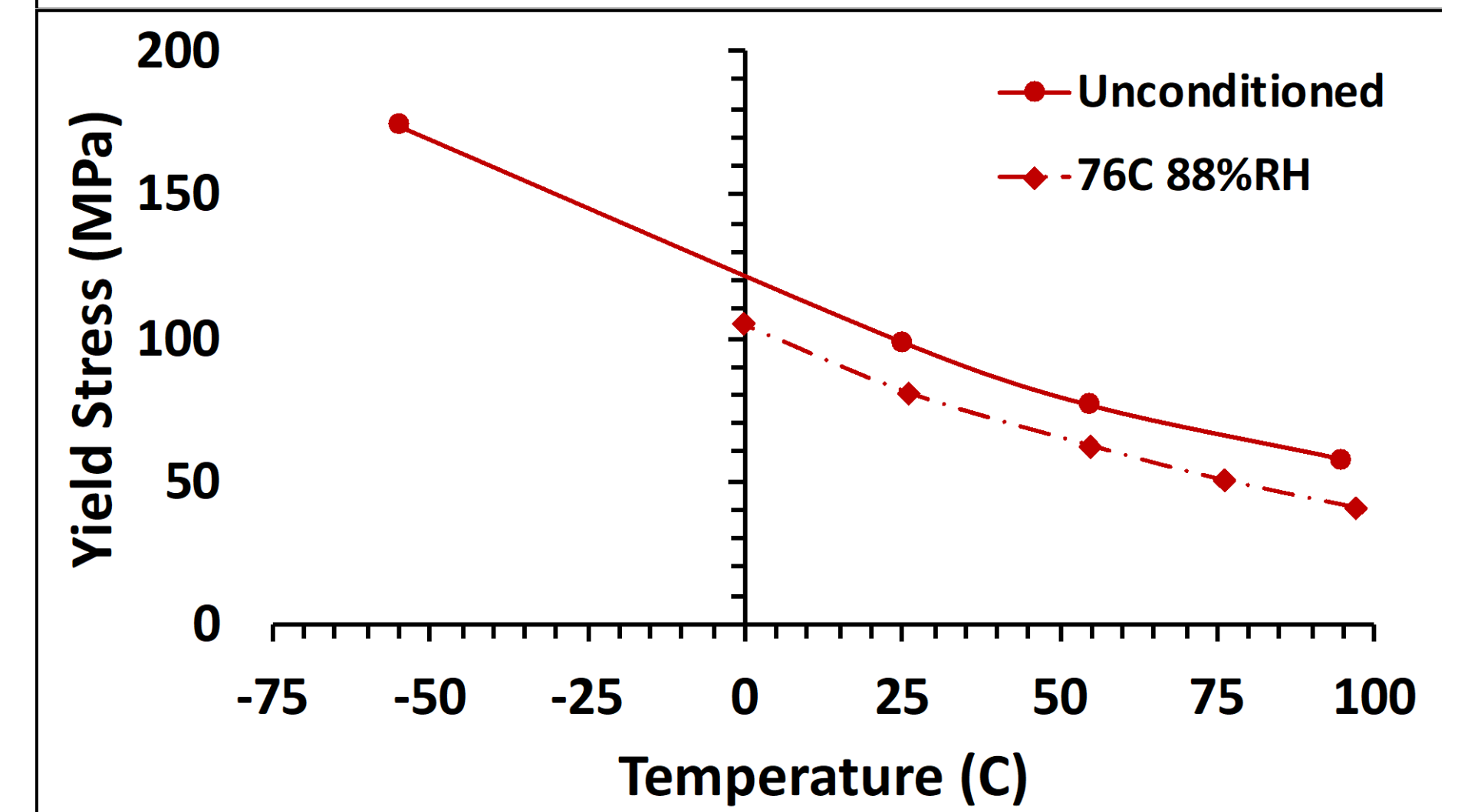
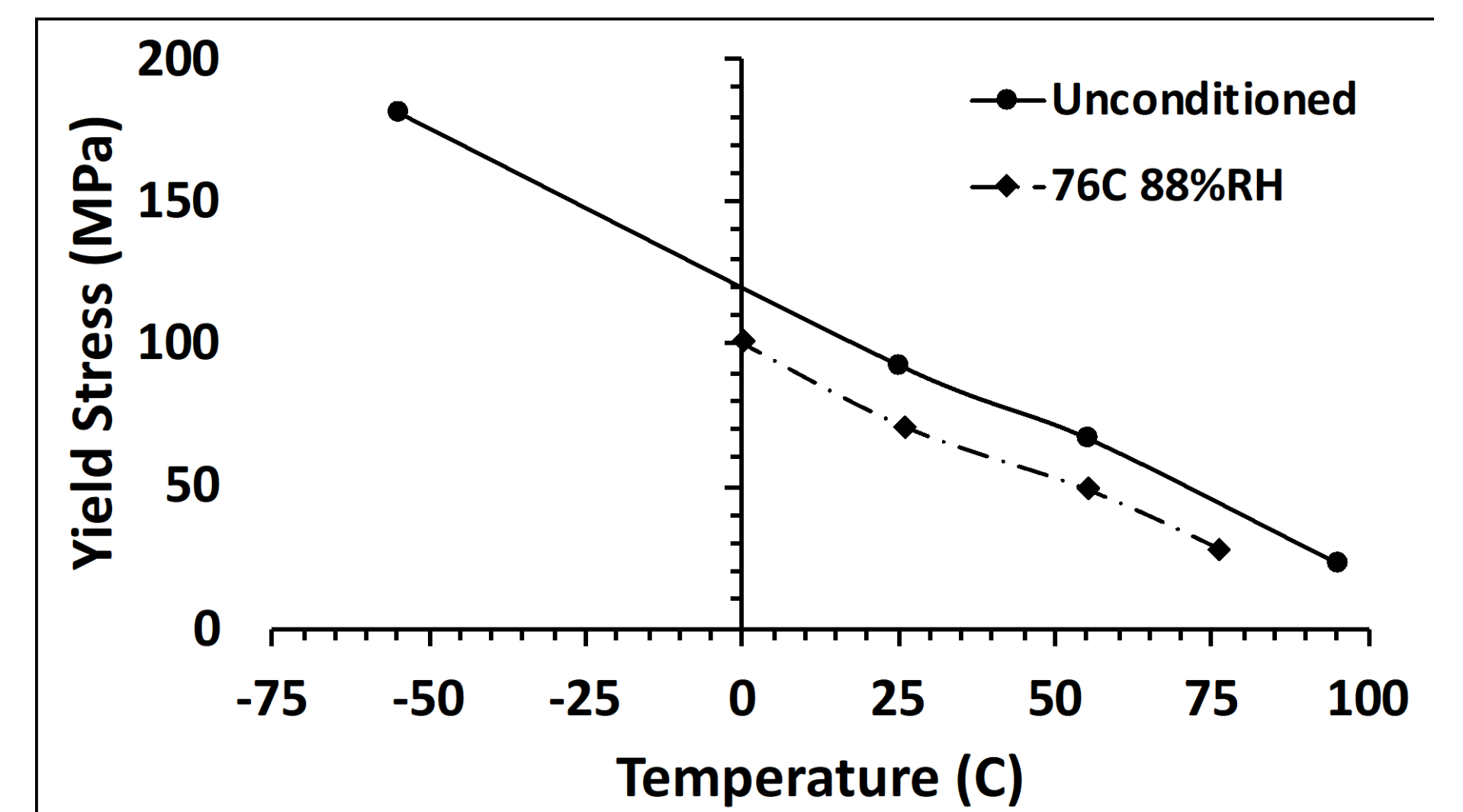


Figure 6: Modulus/Yield Strength for unconditioned samples

- At higher temperatures, RDL-RDC has higher mechanical properties such as yield stress and modulus than SC-15
- With conditioning, properties decrease



Figures 7 & 8: Modulus comparison for conditioned and unconditioned samples



Figures 9 & 10: Yield Strength comparison for conditioned and unconditioned samples

Summary and Conclusion

- To characterize the epoxy resins, a repeatable methodology is created to estimate mechanical properties
- RDL-RDC has a higher glass transition temperature above the current working range
- RDL-RDC is shown to have higher modulus and yield stress at higher temperatures
- In higher relative humidity settings, overall properties decrease due to moisture intake for both resins
- Testing procedures provide a first step towards establishing a framework for estimating MOL

Acknowledgements

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