NEW MEXICO TECH
SCIENCE · ENGINEERING · RESEARCH · UNIVERSITY

Sandia National Laboratories

SAND2018-13999PE

Research Experience and Interests

MARGARET HOUSE

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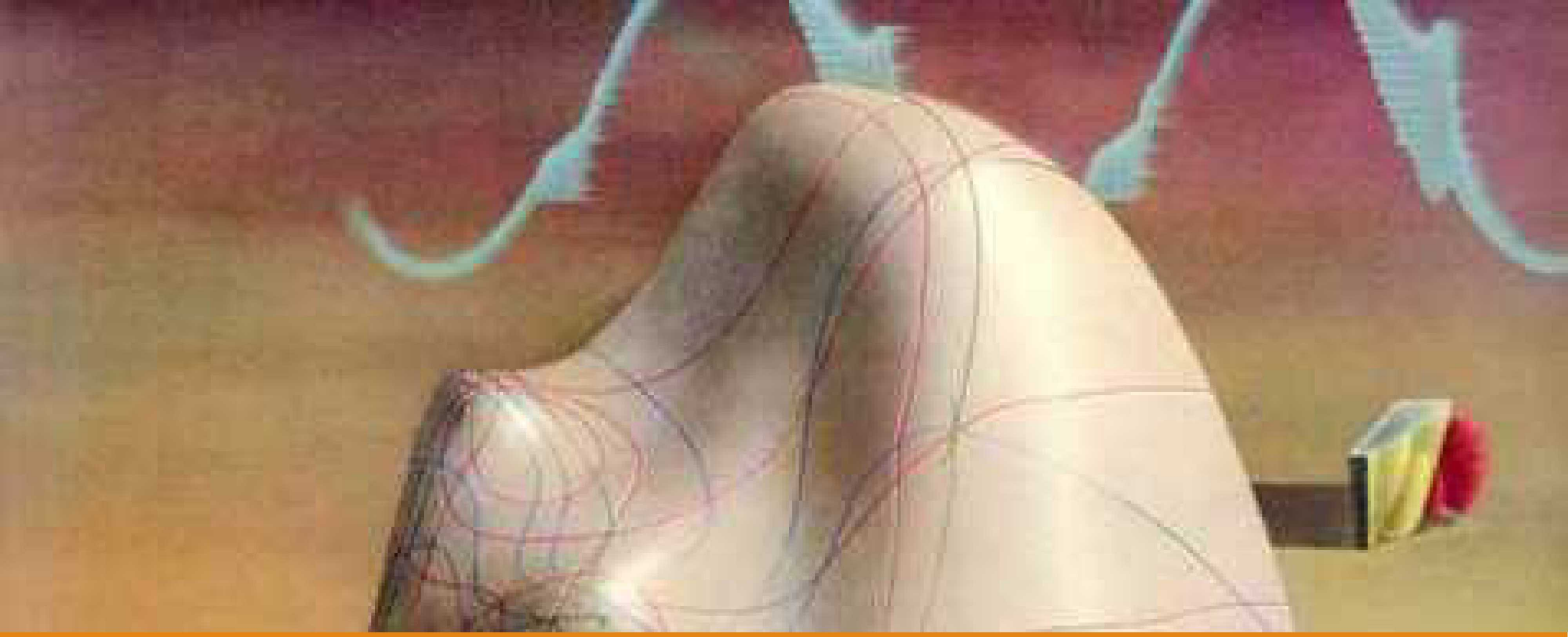
Outline

- My educational background
- My prior and current research positions
- My graduate research interests

My Educational Background

- New Mexico Institute of Mining and Technology (New Mexico Tech)
- Chemical engineering major, senior year
- Two undergraduate research positions held since spring of freshman year



Epoxy and Polymer Research, 2016-2018

New Mexico Tech Materials Engineering Department, Dr. John McCoy

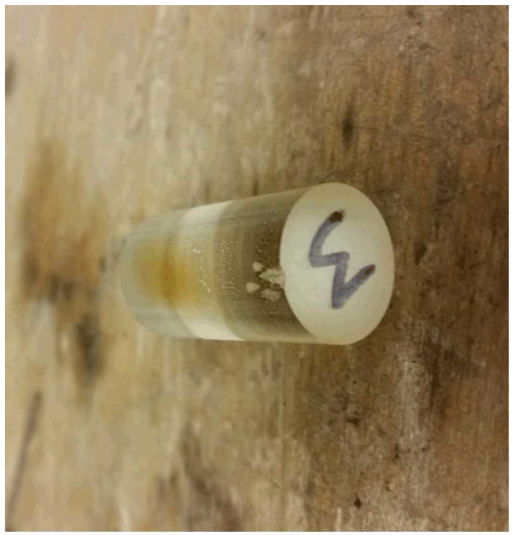
Thermal Rejuvenation in Glassy Polymers

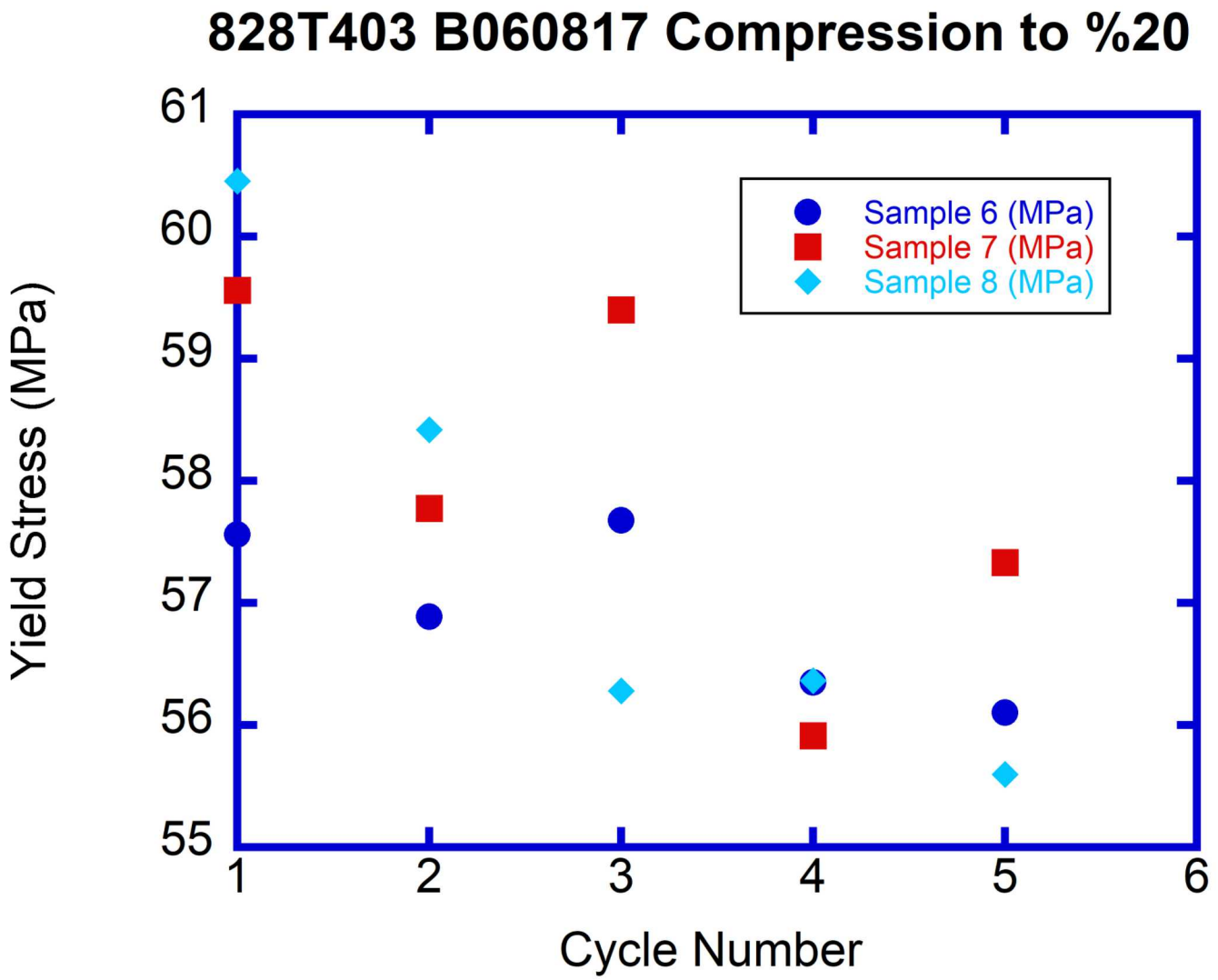
Project

- Epoxy system exhibits mechanical rejuvenation- find trends with repeated testing

My Contribution

- Experiment design, data analysis, and report writing





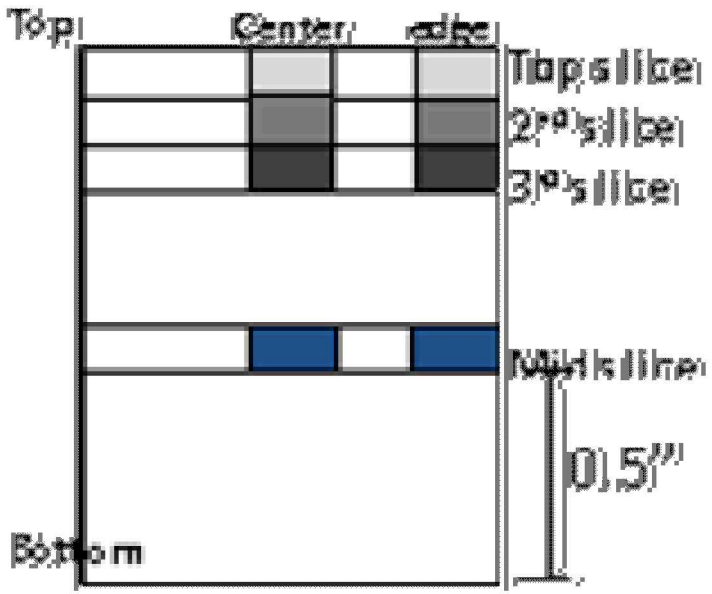
Mechanical Rejuvenation Changes with Sample Location

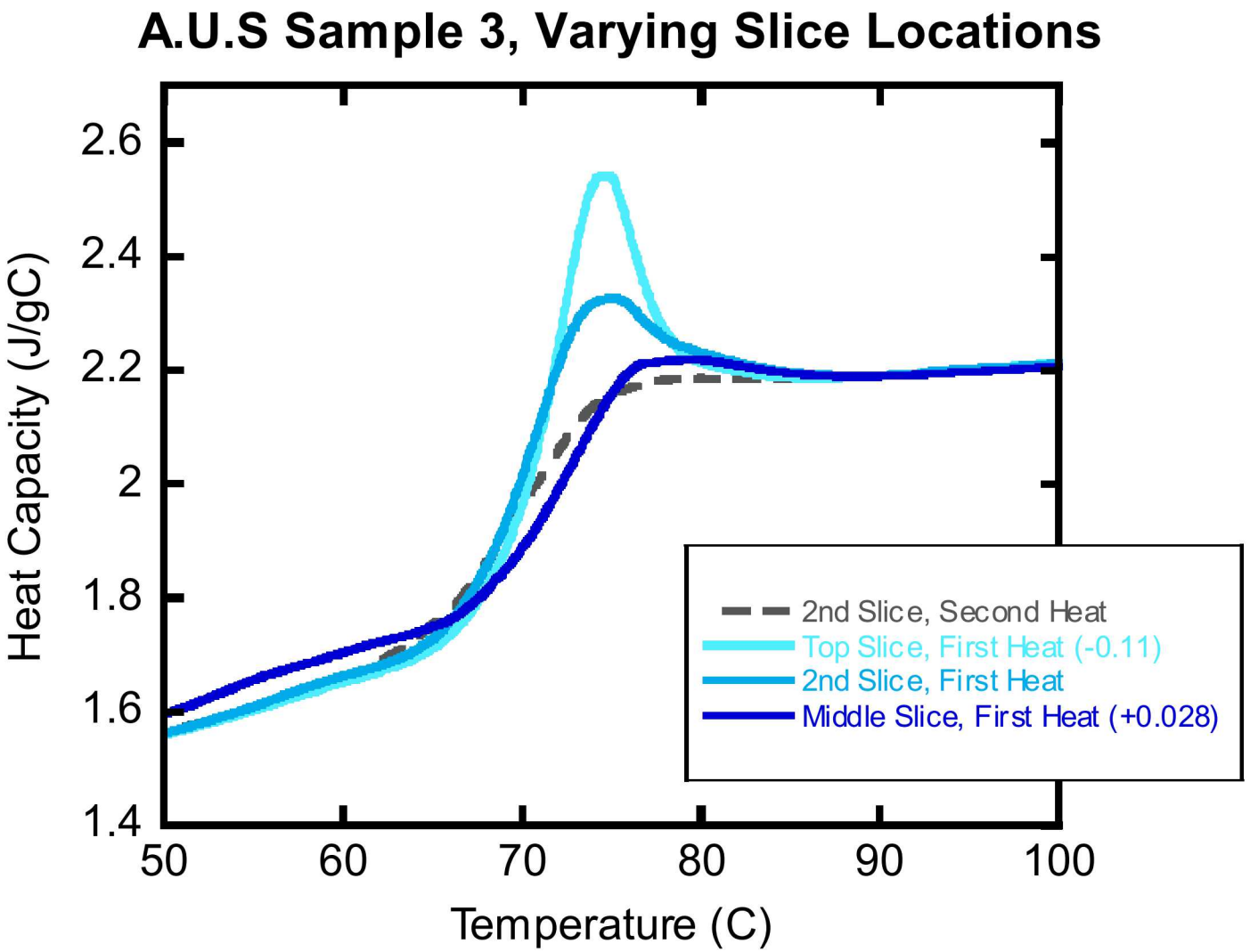
Project

- Epoxy samples began showing inconsistent rejuvenation from test to test

My Contribution

- Ran tests that found that mechanical rejuvenation depends on location in the sample





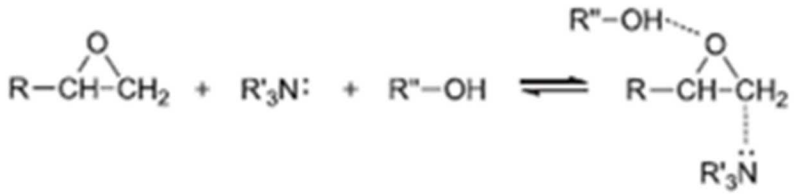
Cure Reaction Kinetics-Hydroxyl Group Contribution

Problem

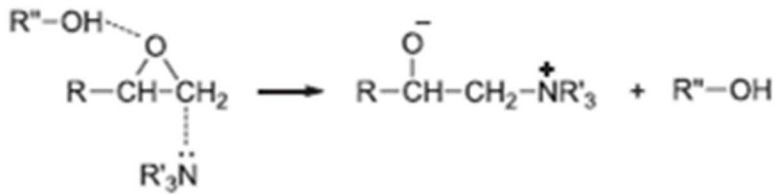
- It is unclear how hydroxyl groups affect epoxide-amine reactions
  - Expectation: more hydroxyl groups drives transition state formation and proton transfer, so the more hydroxyl groups, the faster the reaction

Project

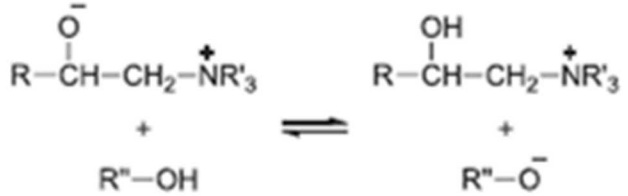
- Study effects of removing available hydroxyl groups from DGEBA:DEA reaction



a) Transition state formation

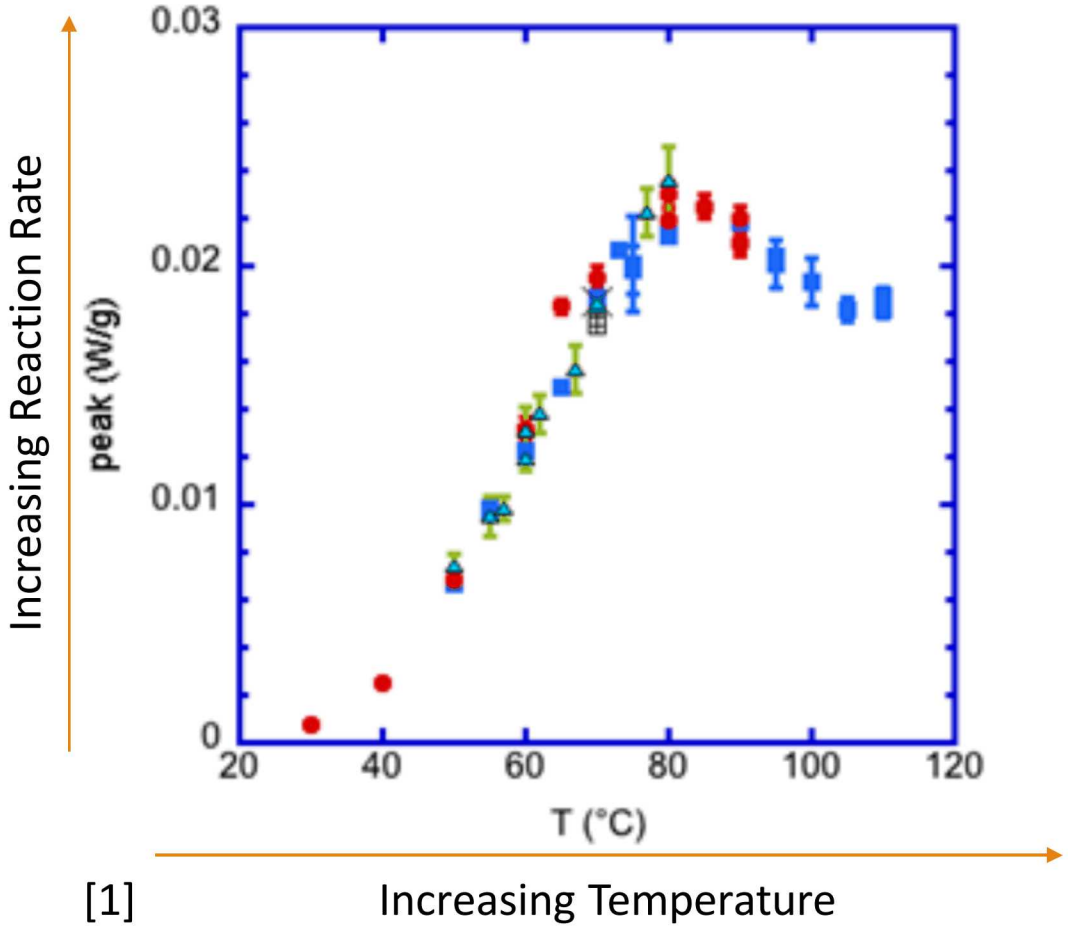


b) Zwitterion formation



c) Proton transfer

Cure Reaction Kinetics-Hydroxyl Group Contribution



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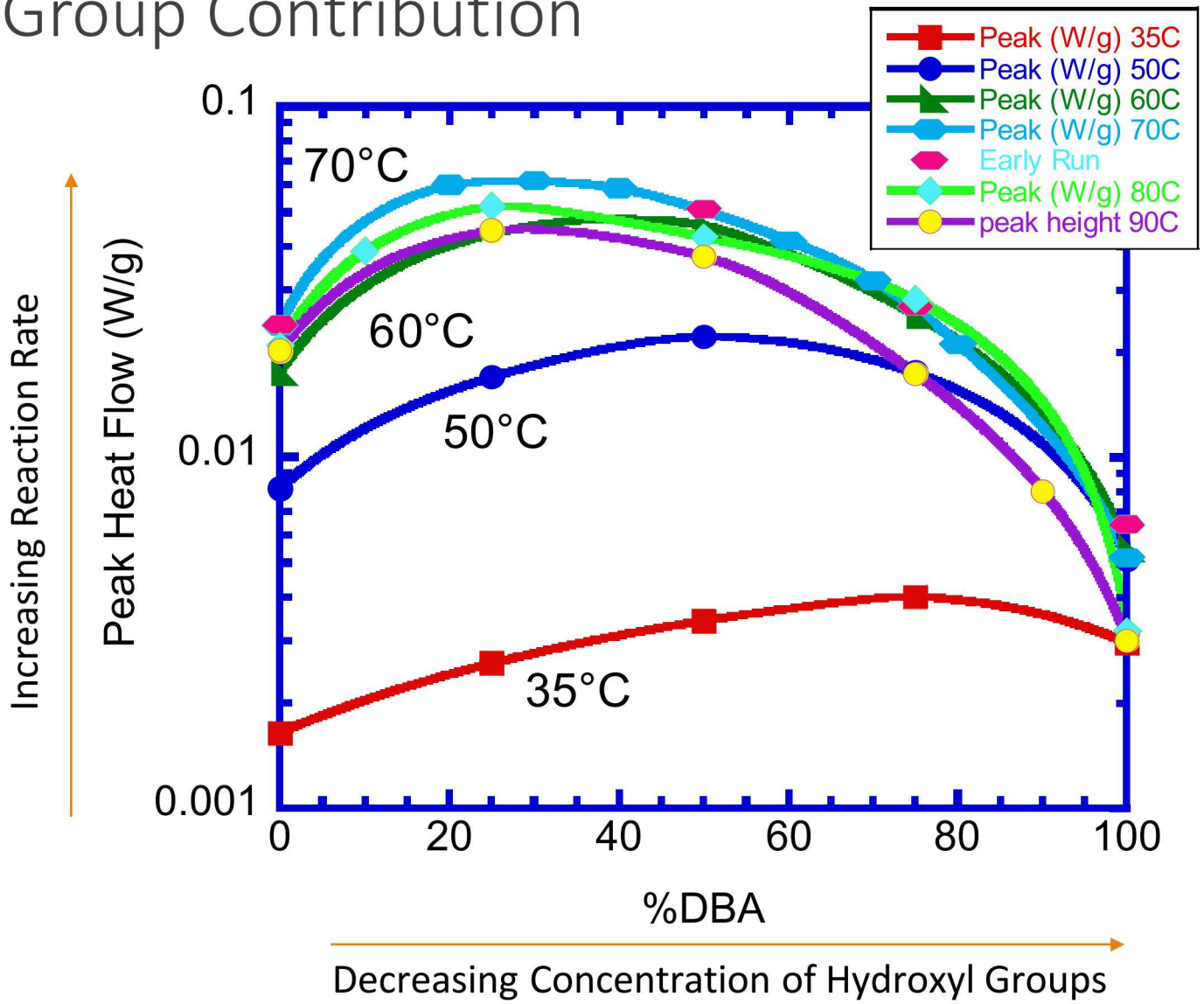

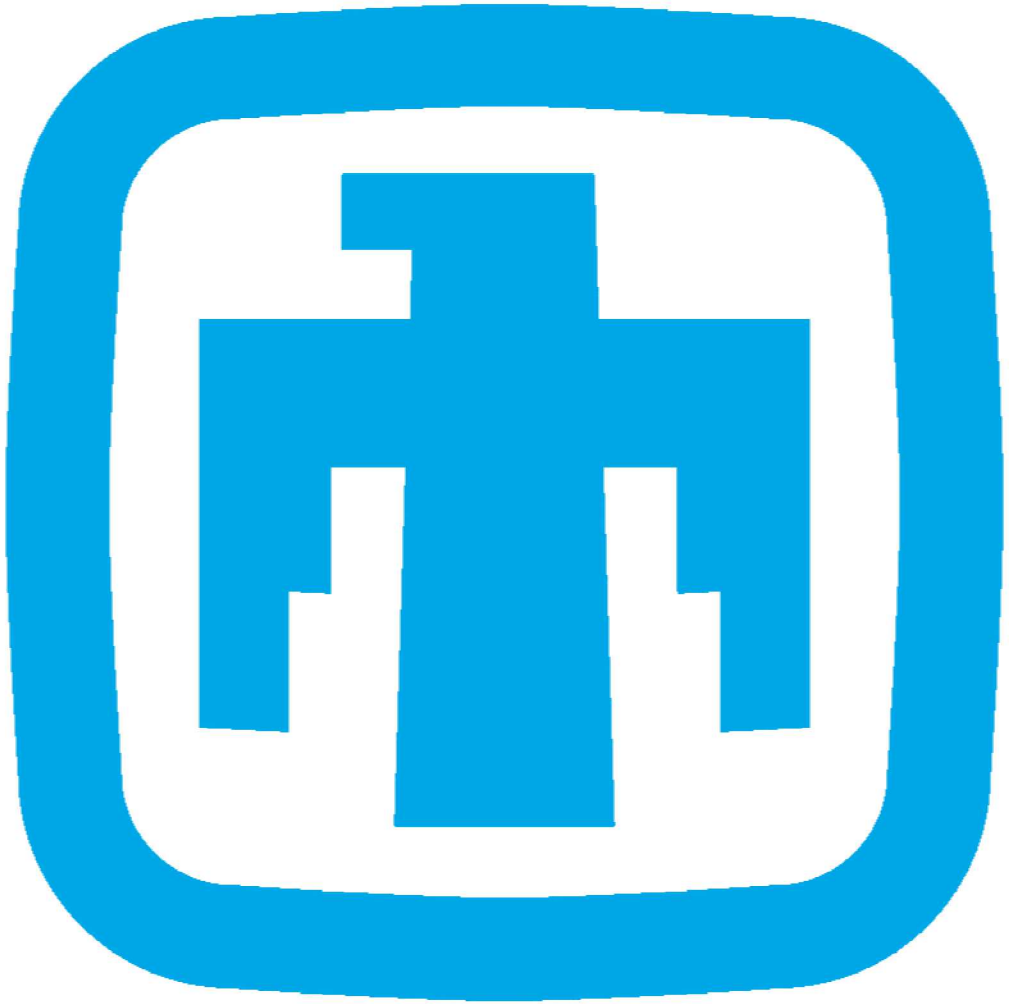

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Epoxy Reaction Research, May 2018-Present

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Epoxy-Anhydride Reactions Need Accelerants

Problem

- Epoxy-anhydride system- slow reaction
- Accelerant currently used is no longer produced

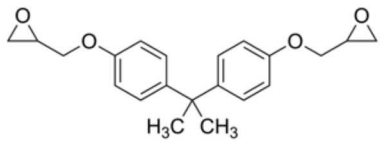
My Research

- Goal: Find a replacement accelerant
  - Use DSC to study a range of replacement accelerants
  - Optimize processing (ease of measuring and mixing), cure (time), and post-cure (modulus) characteristics
  - Recommend new accelerant to PRT

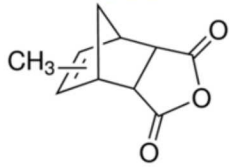
System

Resin + Anhydride + Alcohol + Catalyst

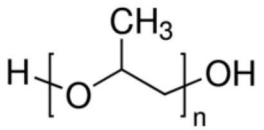
DGEBA
Epon 828



Nadic Methyl Anhydride HY 906

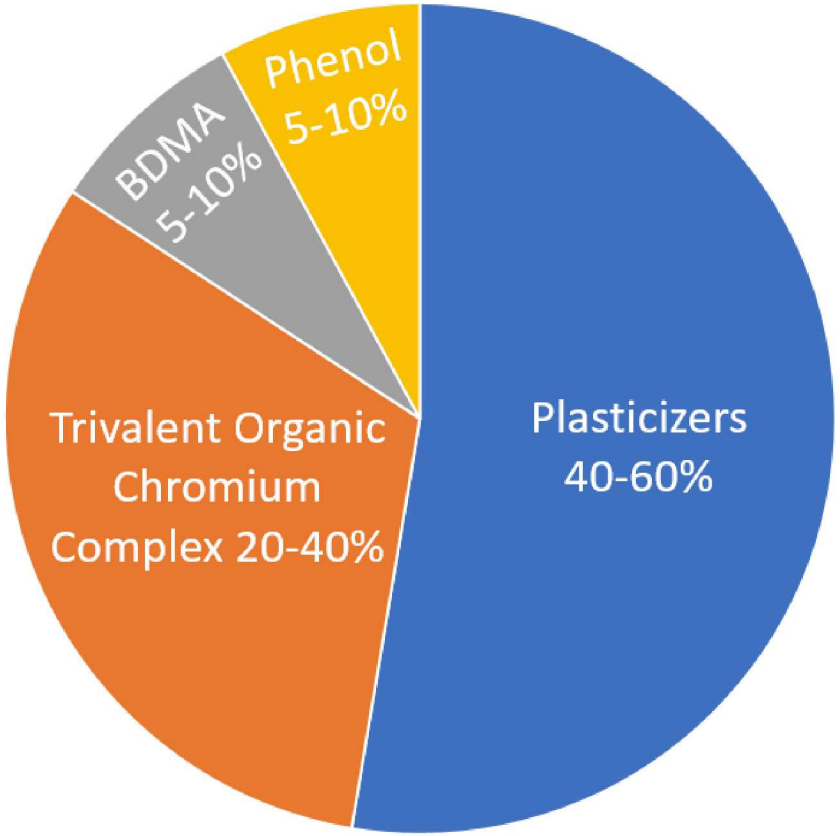


Polypropylene Glycol 1025 (flexibilizer)

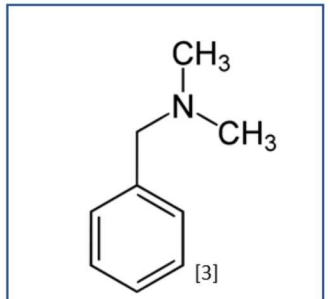


ATC-3

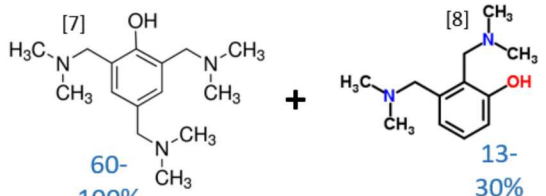
828	50
NMA	42
1025	20
ATC-3	3
total	115



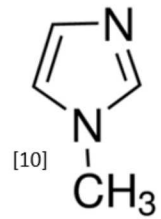
Screening Tests-Initial Accelerant Choices



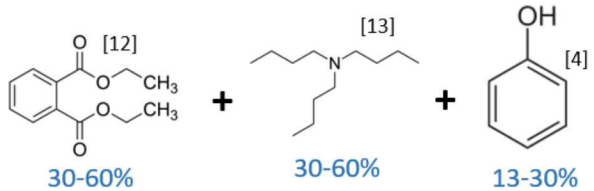
BDMA DY062
[6]



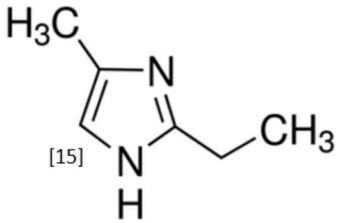
Aminophenol
960-1 [9]



1-methylimidazole
DY070 [11]



Phthalate Amine Phenol
Compound DY073-1 [14]



2-ethyl-4-methylimidazole
[16]

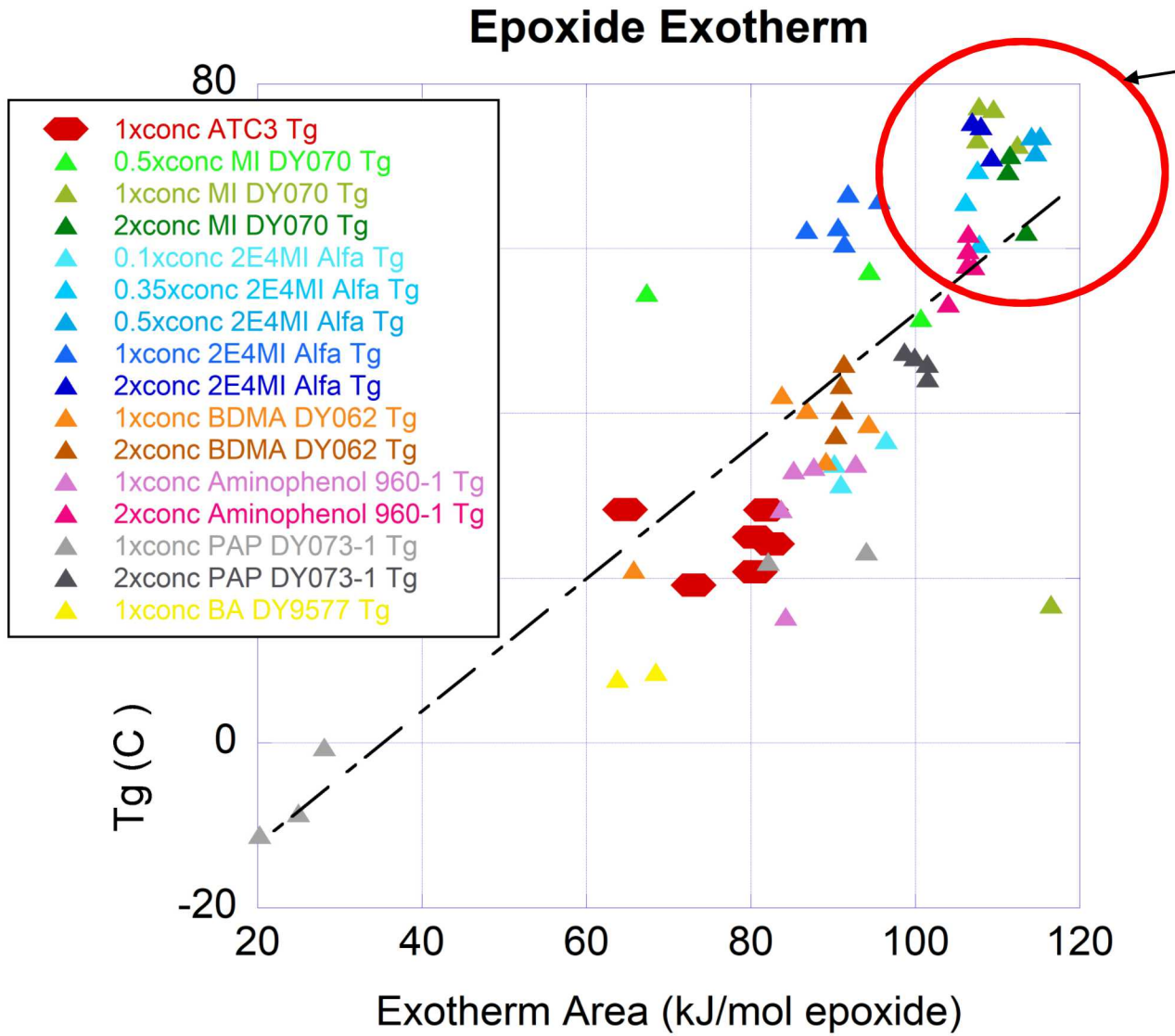
Problem:

24 hour tests on 5 accelerants at different concentrations will take months

Solution:

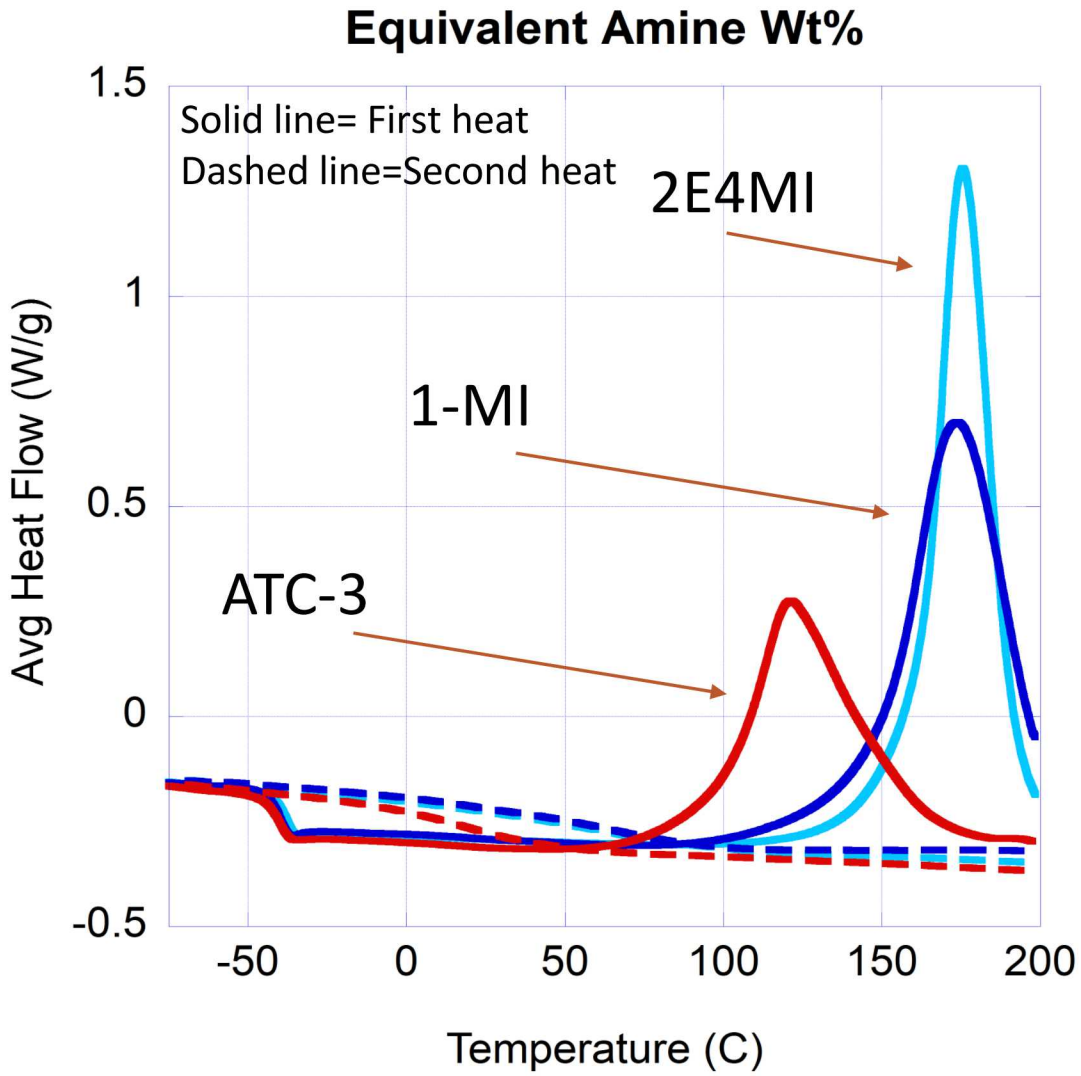
Ramps to high temperatures allow for fast comparison between accelerants

Screening Tests-Results



Highest Tg and exotherm, indicating more complete reaction

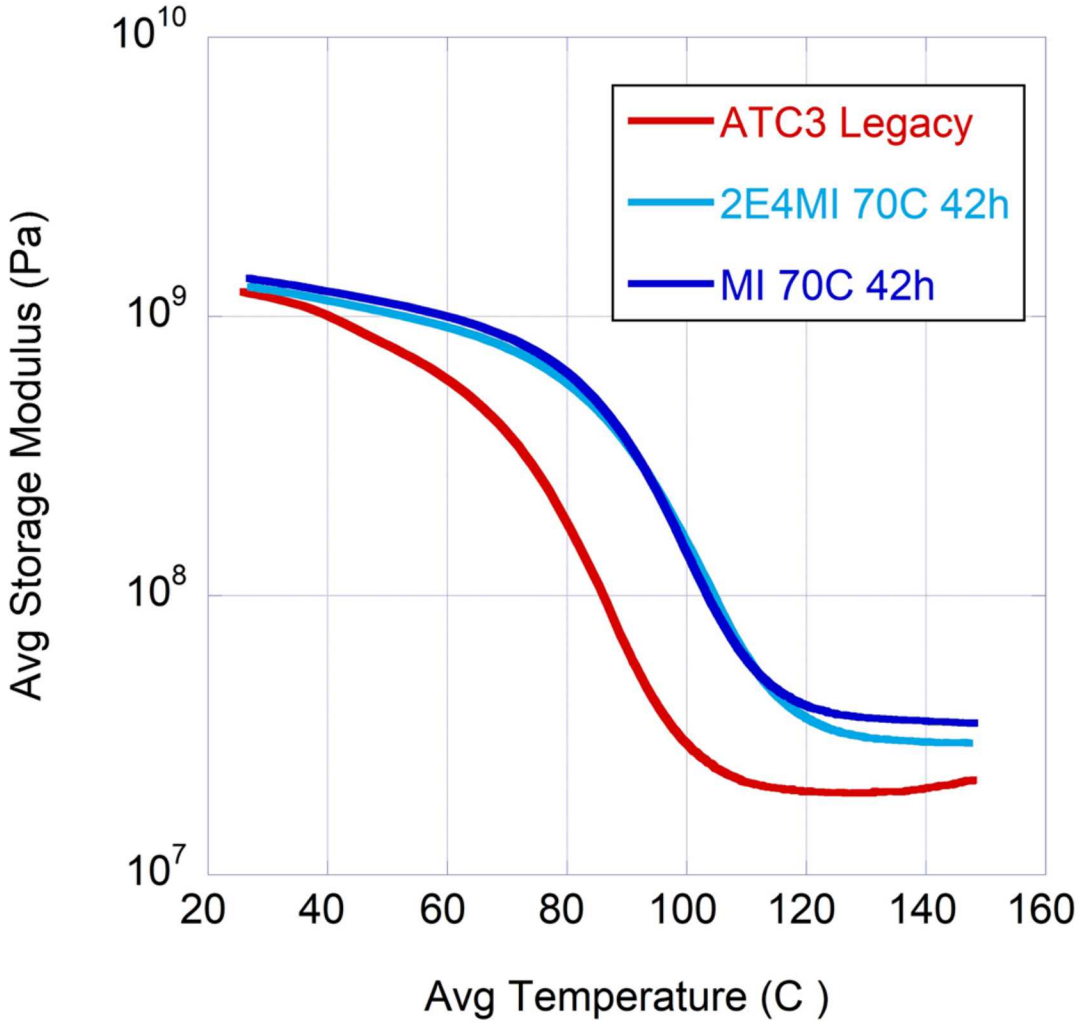
Replacement Accelerant DSC Characterization

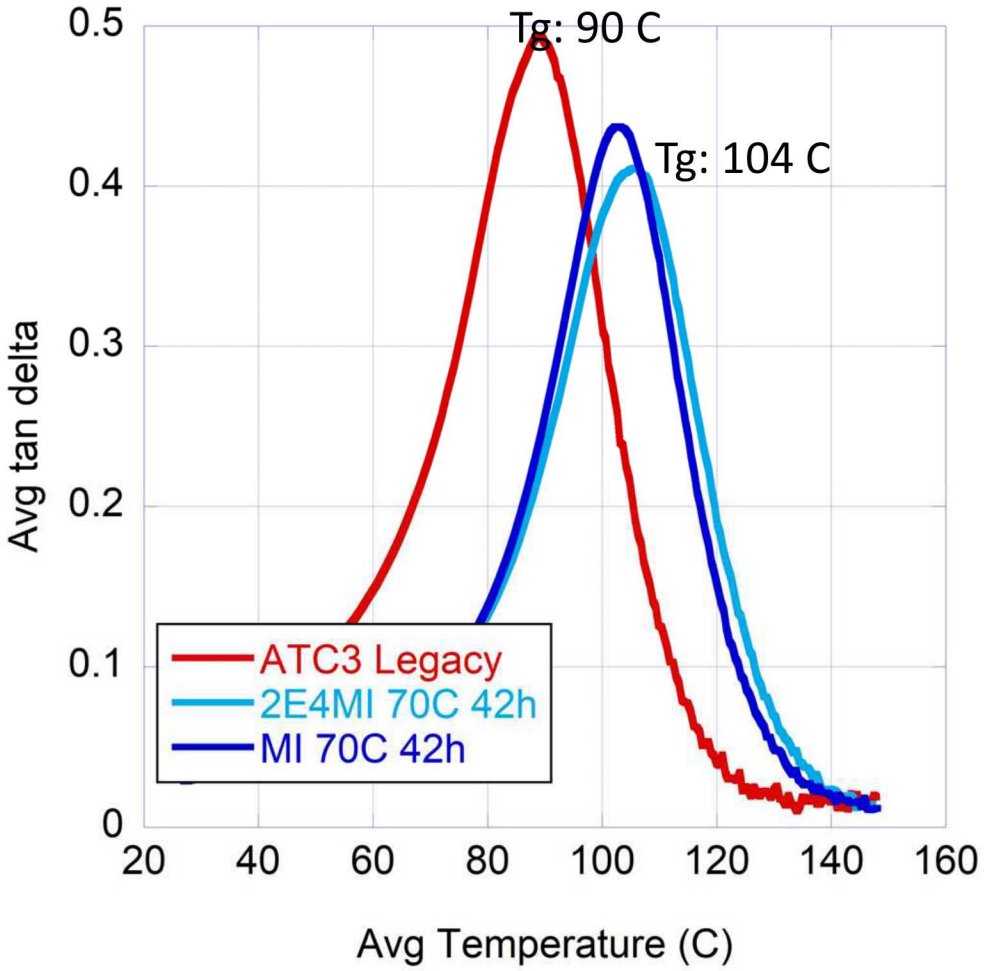


	Exotherm Area (J/g)	Tg 2 (C)	Tg 3 (C)
ATC-3	178.1	24.3	27.5
1-MI	233.3	67.2	70.2
2E4MI	239.9	63.6	67.2

Higher Tg, longer pot life

Replacement Accelerant Mechanical Characterization





Replacement Accelerant Conclusions

Conclusions

- Recommend MI or 2E4MI at 0.026 wt%
- Advantages: Higher Tg and modulus, longer pot life
- Disadvantages: Precision required in mixing

Reception

- Presented work to PRT
- Replacement has advantages and could be implemented in 5+ years

Future Work

- Aging studies
- Studies on role of poly-ol

My Graduate Research Interests

RESEARCH TOPICS

- Nanomaterials
- Polymers
- Advanced material synthesis and characterization
- Alternative energy applications for nanomaterials and advanced materials

GRADUATE SCHOOL CHARACTERISTICS

- Low student:faculty ratio
- Connections with industry
- Competitive funding

References

Gibbs Surface Image: https://www.periodpaper.com/collections/magazine-covers

SNL Logo Image: https://commons.wikimedia.org/wiki/File:Sandia_National_Laboratories_logo.svg

Sandia Mountains Image: http://www.ourladyofthesandias.org/the-sandia-mountains

[1] McCoy et. Al *"Reactions of DGEBA epoxy cured with diethanolamine: Isoconversional kinetics and implications to network structure".* Thermochimica Acta, **2019**.

Thank you!