

Statistical Evaluation of Mixedness in a Carbon Sequestering Polymer-Ceramic Composite

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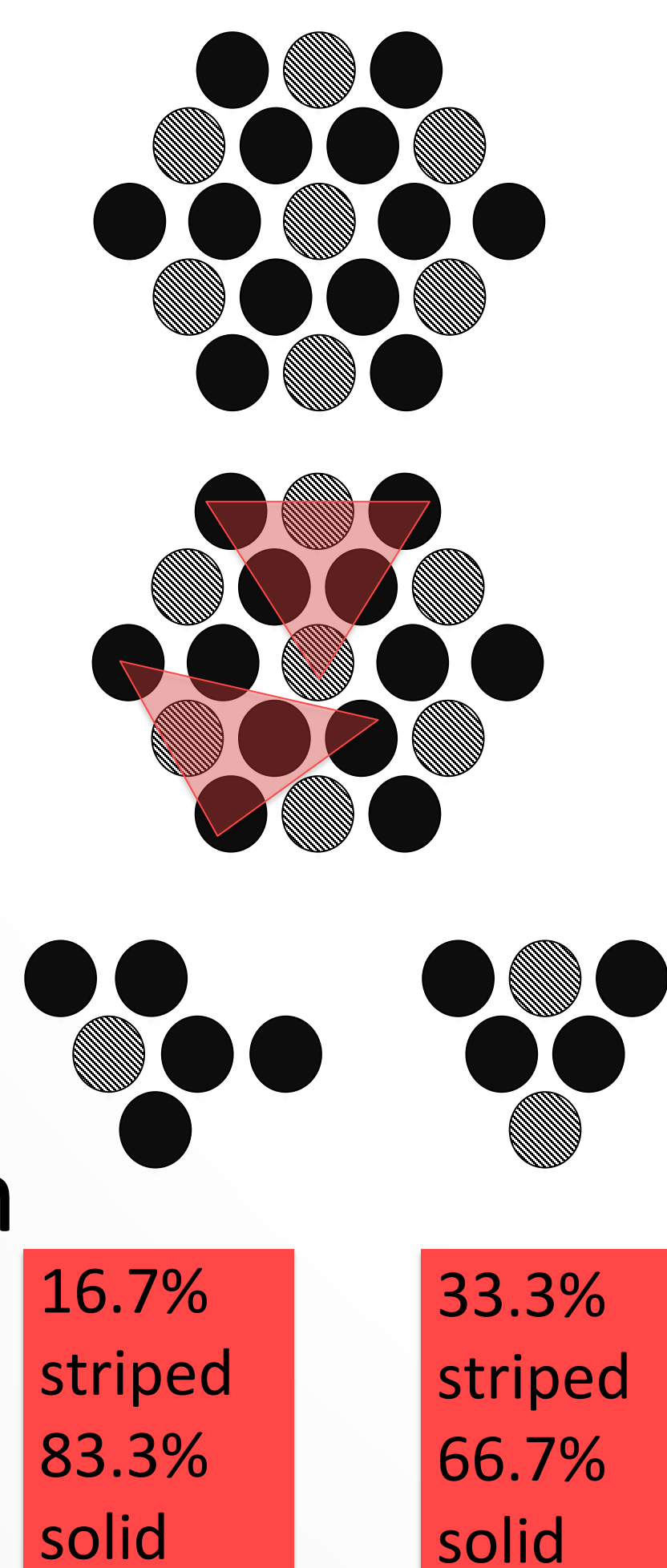


Introduction

- Fabrication of polymer-ceramic composite
- Powder mixture of components mixed in Spex mill
- Undergoes Gas-Reactive Hydrothermal Liquid Phase Densification (g-rHLPD)
 - Material strengthens, can sequester 0.38g of CO₂ per gram of initial ceramic powder
- High-Density Polyethylene (HDPE) induces toughness in calcium silicate (CaSiO₃) matrix
- Uniform polymer particle distribution essential for consistent, desirable mechanical properties
- Goal: Determine statistical significance of variation of mixedness in powder mixture batch with specific composition

Methodology

- Consider: well-mixed batch of striped and solid dots
 - 36.8% striped, 63.2% solid
- 2 samples: 6 dots → Sample composition varies
- Potential variation in mixture sampled multiple times
- Simultaneous thermal analysis (STA) measures polymer fraction burnout
 - HDPE 100% decomposes ≈ 500°C
- Given Spex mill mixes homogeneously, mass percent decrease = overall intended mass percent polymer



Experimentation

- A single batch with volume composition of 85:15 CaSiO₃ to HDPE
- Mixed via Spex mill

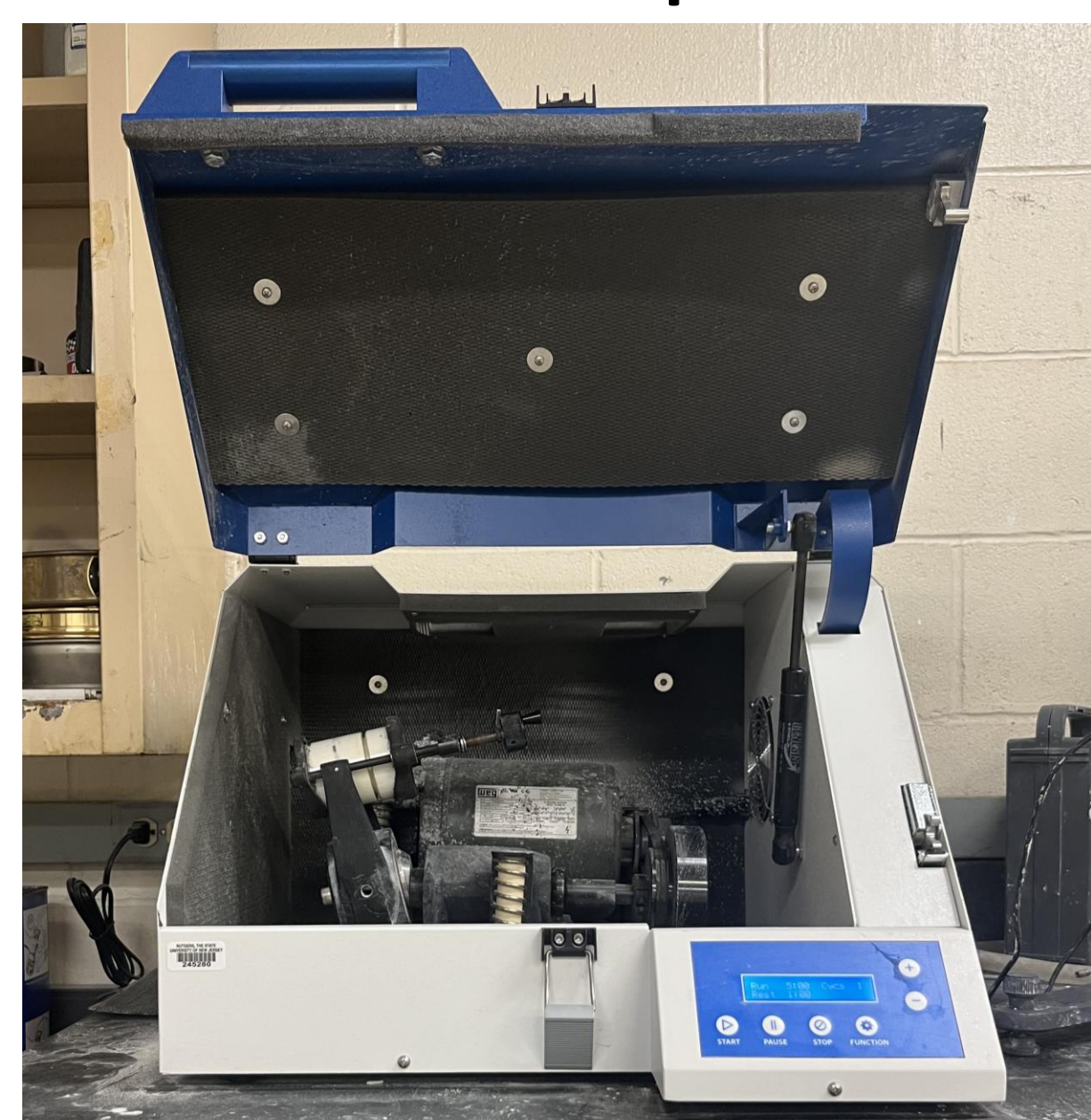


Figure 1: The inside of a Spex mill, set to mix.

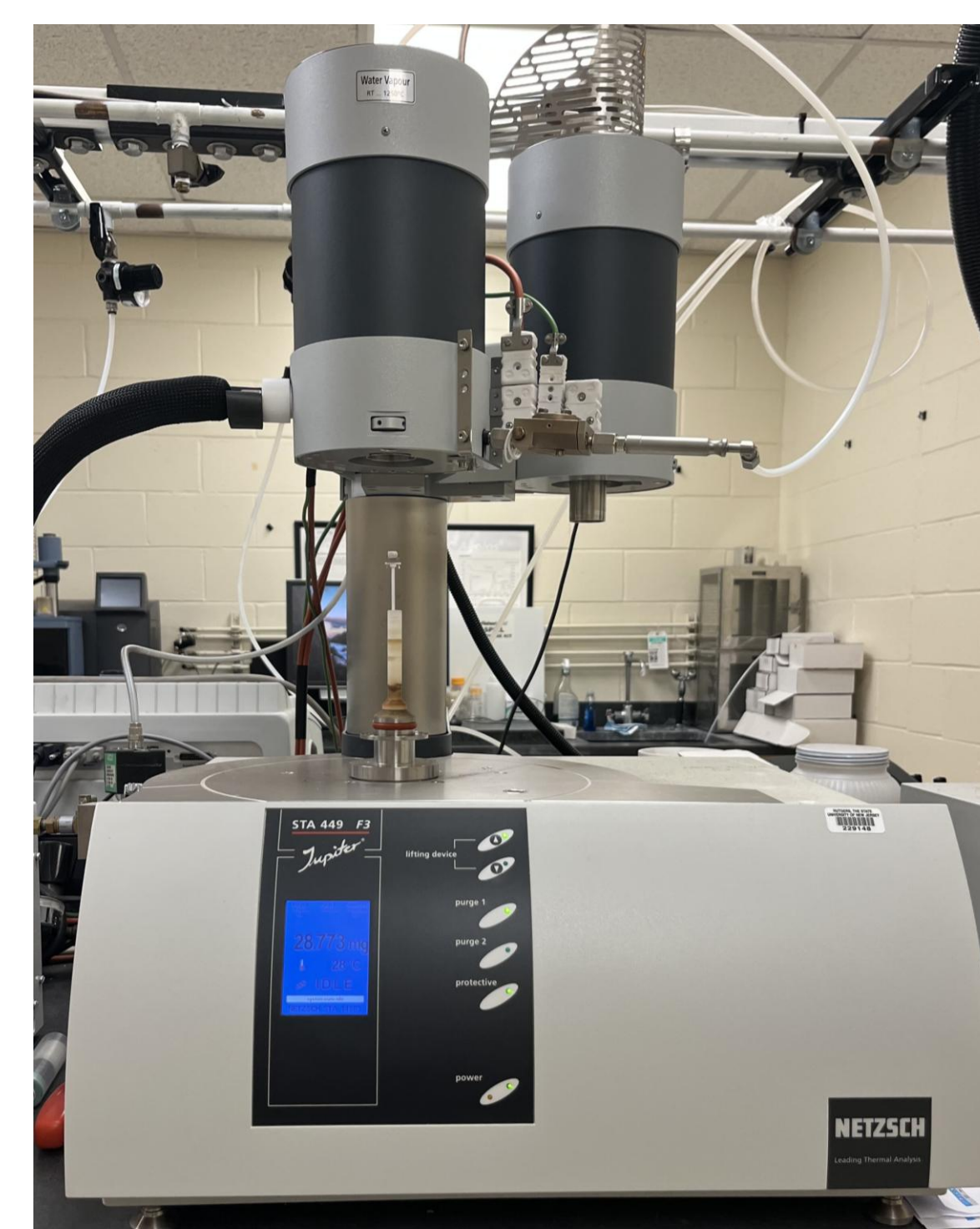


Figure 2: NETZSCH STA 449 F3 Jupiter Simultaneous Thermal Analyzer prepared to begin measurements.

- STA Program
 - Heat 10°C/min up to 600°C
- 30 samples from one batch analyzed

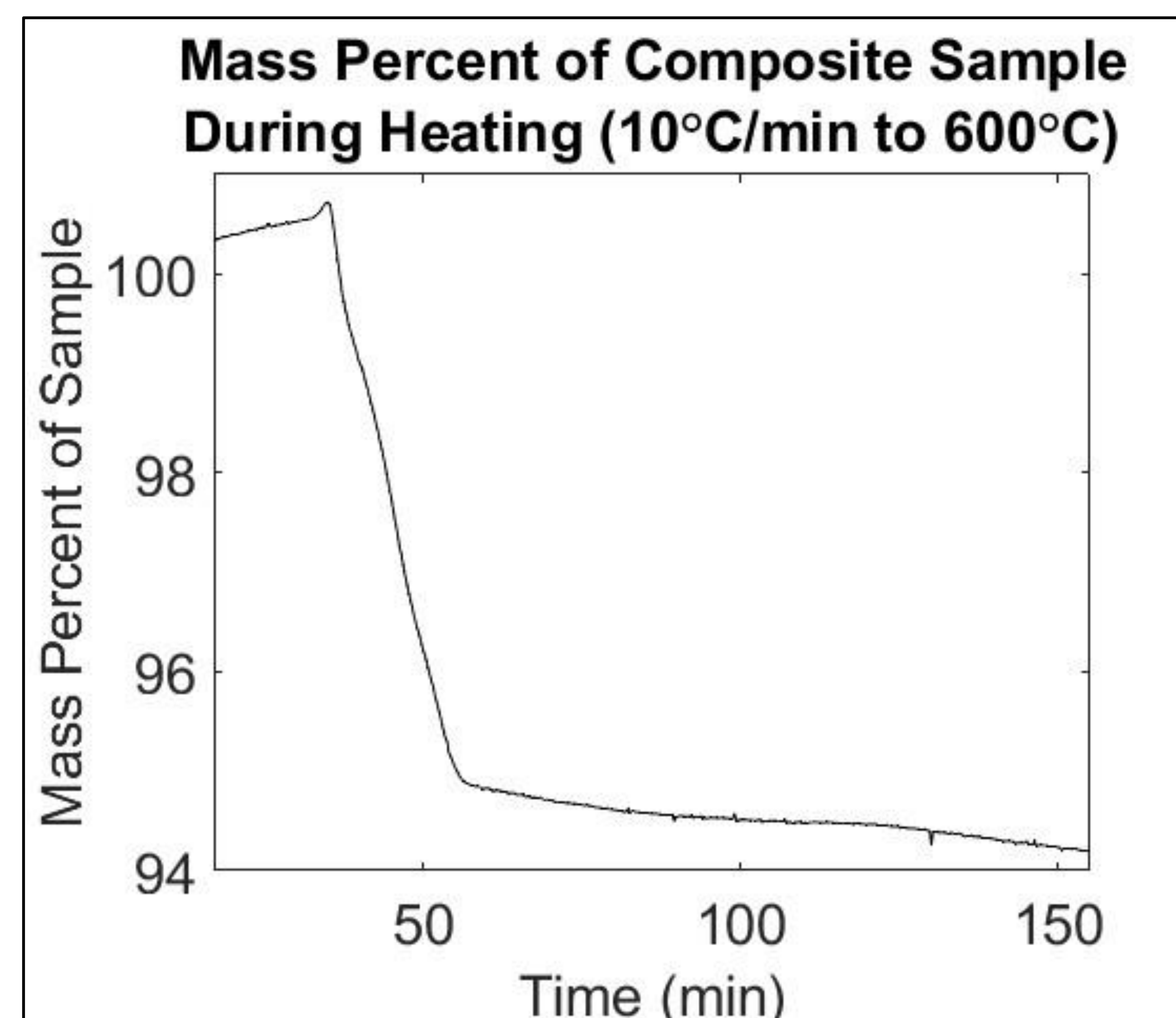


Figure 3: STA plot of composite sample heated from room temperature to 600° C at 10° C/min and then isothermally held.

Acknowledgments

This project would not have been possible without the guidance and support from Distinguished Professor Dr. Richard Riman of the MSE Department and my mentor, Noemie Denis, a PhD student in Dr. Riman's labs.

Analysis & Results

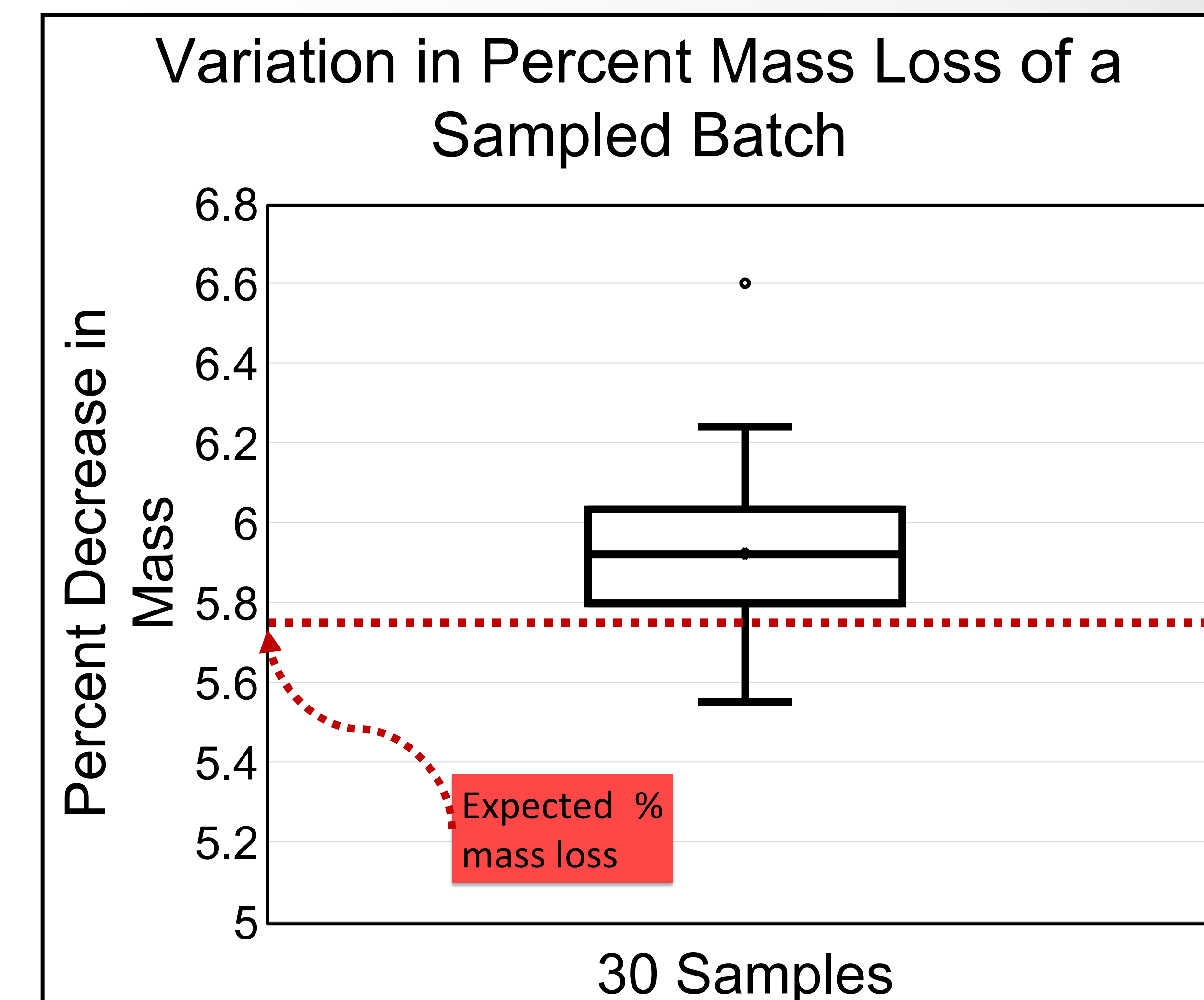


Figure 4: Box plot of percent mass loss for each sample from the batch.

- Target volume composition of 85:15 has average polymer fraction 5.92% ± 0.213
- T-test performed at 0.05 significance level, compare experimental mean to expected fraction of HDPE - 5.74% **P = 0.999 > 0.05**

Conclusions

- Difference between experimental quantity of HDPE in samples and the intended amount is not statistically significant
- Spex mill homogeneously processes components
- Samples show batch volume composition, will have engineered mechanical properties

Future Work

- Four mixed batches will be evaluated for the batch-to-batch consistency of the mixtures
- Analysis of variance testing