



**Defence Academy**  
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*Cranfield*  
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# Effect of Manufacturing Processes on Nitrocellulose in Extruded Double Base Propellants

Presented by James Tucker

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# Research aims

- Thesis Title ‘Whole life assessment of extruded double base propellant’
- This research aims to investigate how the process of extrusion can affect the chemical composition the extruded double base propellant

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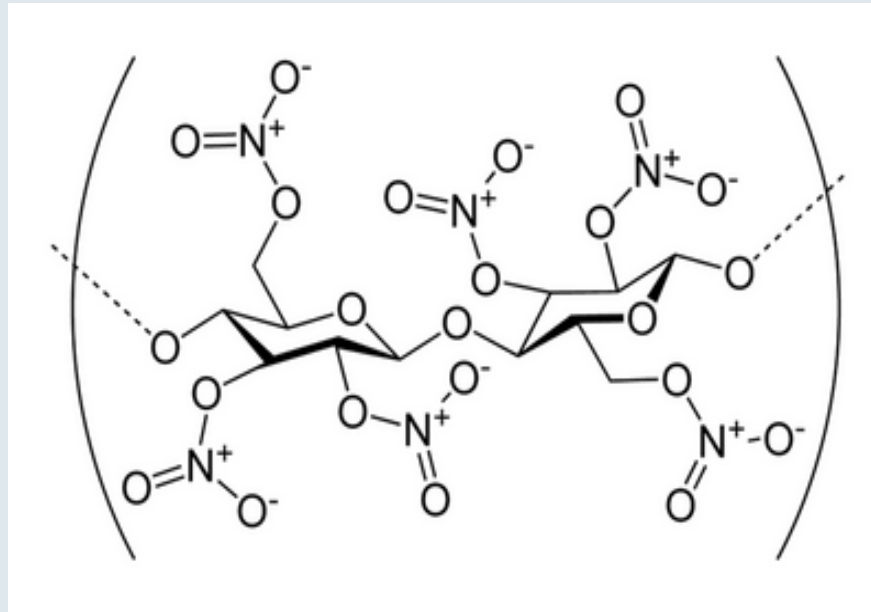
- Introduction to Double Base Propellant
- Theory
- Samples
- Results from Chemical Analysis
- Results from Thermal and Mechanical Analysis
- Discussion

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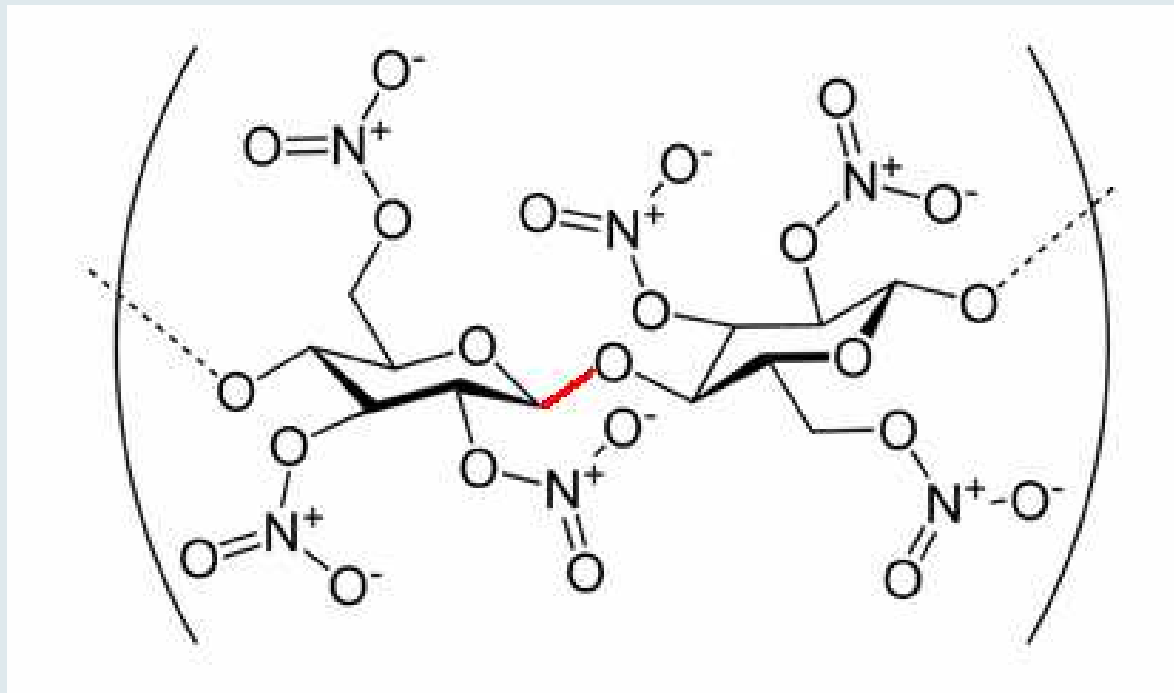
# Introduction to Double Base Propellant

- Nitrocellulose (NC)
- Energetic, Oxygen Balance ~ -30%
- Polymer, acts as binder
- Degraded over time



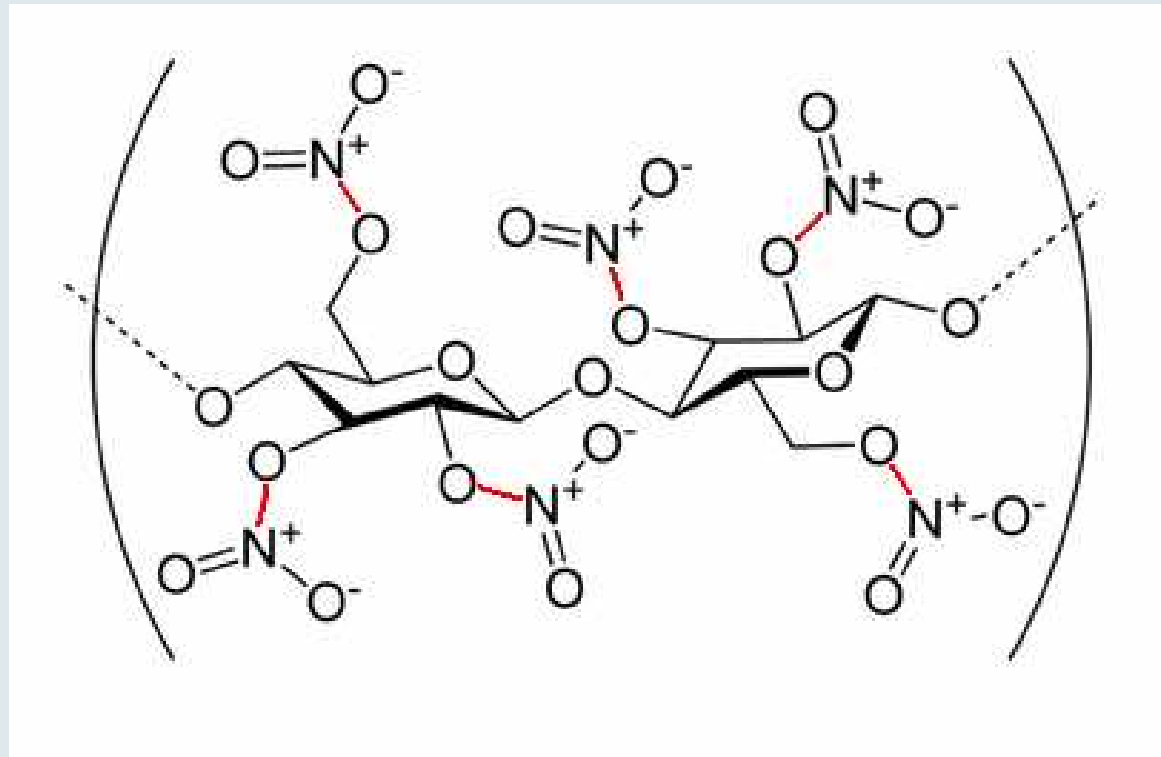
# Introduction to Double Base Propellant

- Chain Scission
- $E_a \sim 160,170 \text{ kJ/mol}$



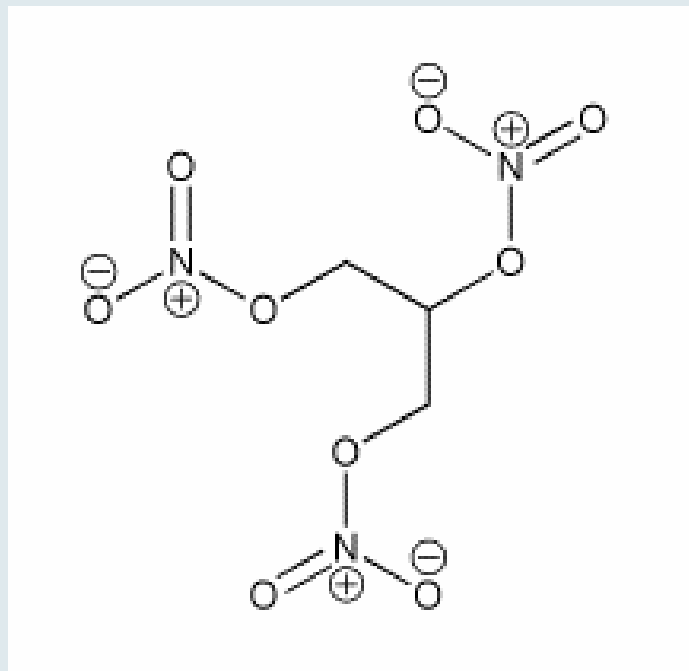
# Introduction to Double Base Propellant

- De-Nitration
- $E_a \sim 100\text{kJ/mol}$



# Introduction to Double Base Propellant

- Nitroglycerine (NG)
- Energetic, Oxygen Balance 3.5 %
- Acts as a plasticiser





# Introduction to Double Base Propellant

- Uses of Double base propellants

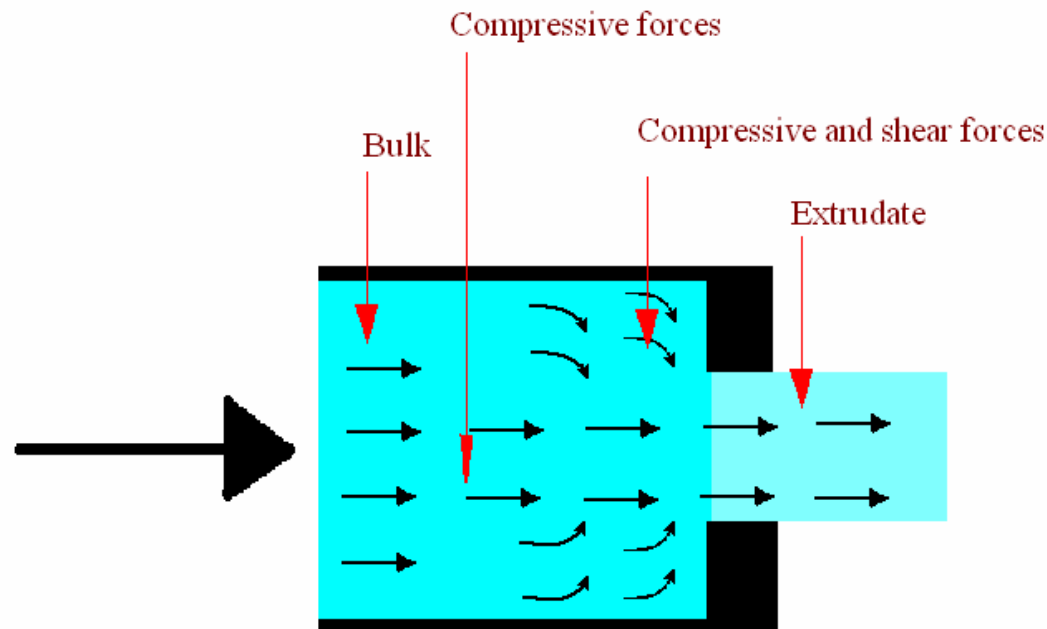


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# Theory

- Ram Extrusion
- Heat
- Pressure
- Decomposition, Chain Scission, De-nitration

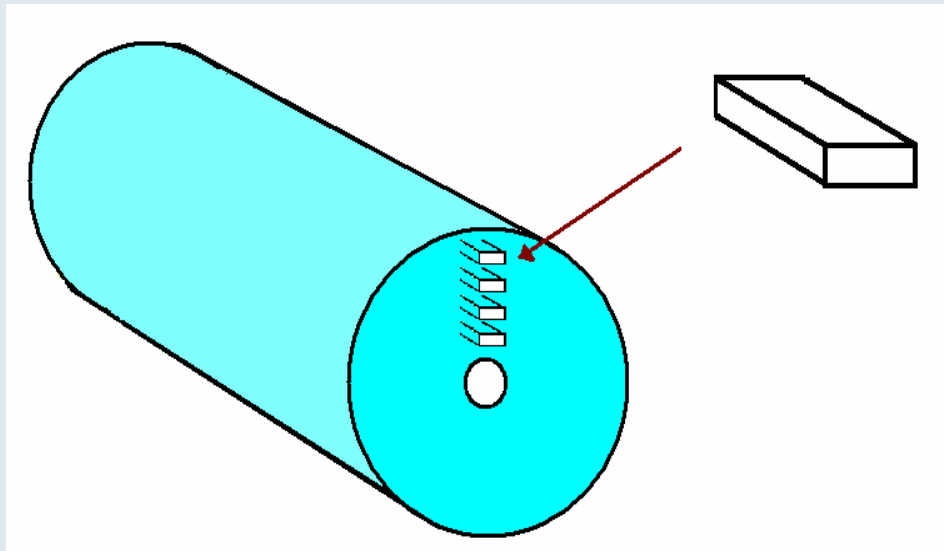


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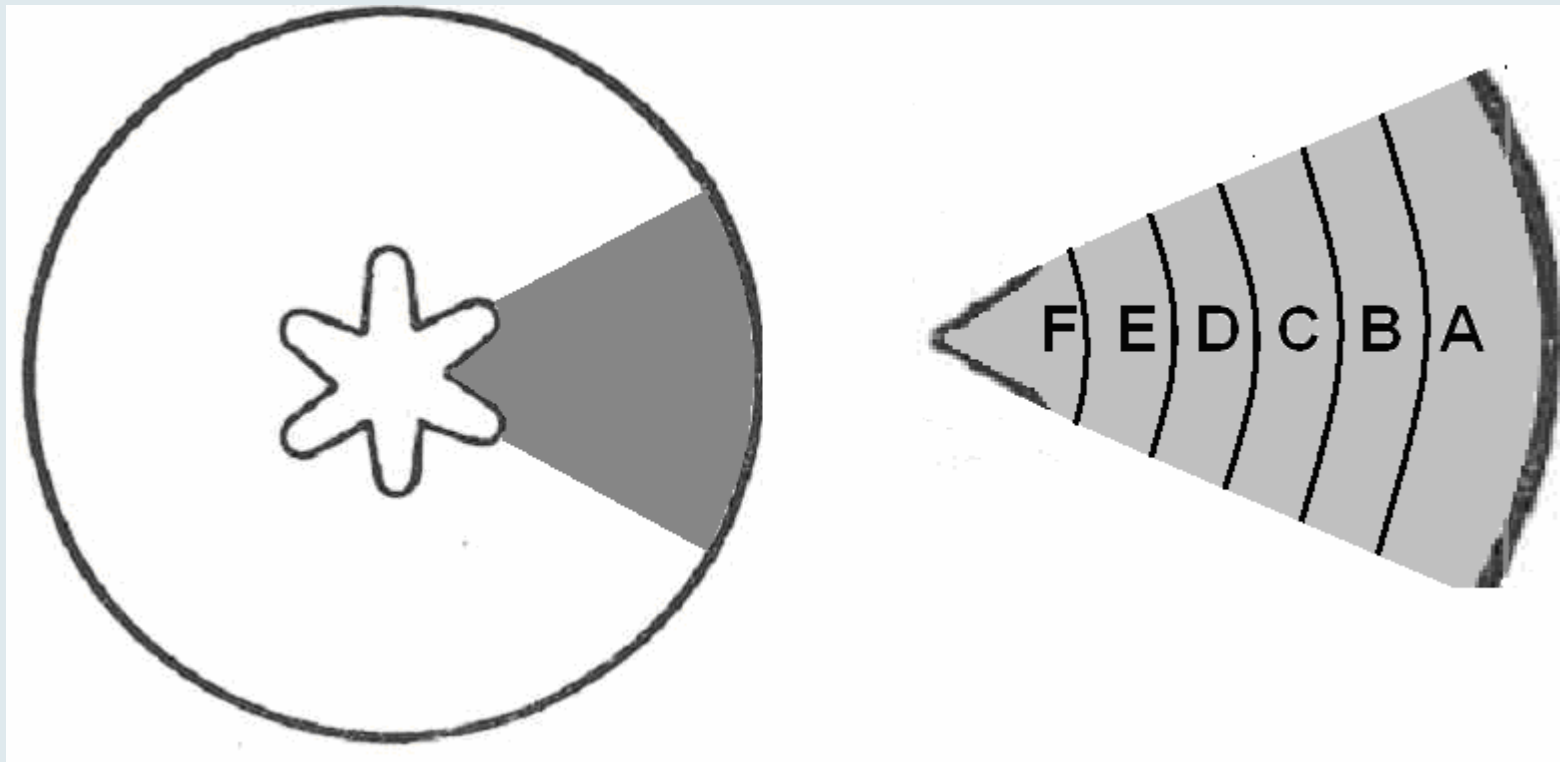
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# Samples

- Samples from different parts of the propellant grain were analysed
- Polymer chain length (GPC)
- Concentration of NG (HPLC)
- Thermal and mechanical properties (DSC)(DMA)



# Samples



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# Results from Chemical Analysis

- The HPLC confirmed that the concentration of NG remained constant
- The GPC measured no variations in the polymer chain lengths or distribution between samples

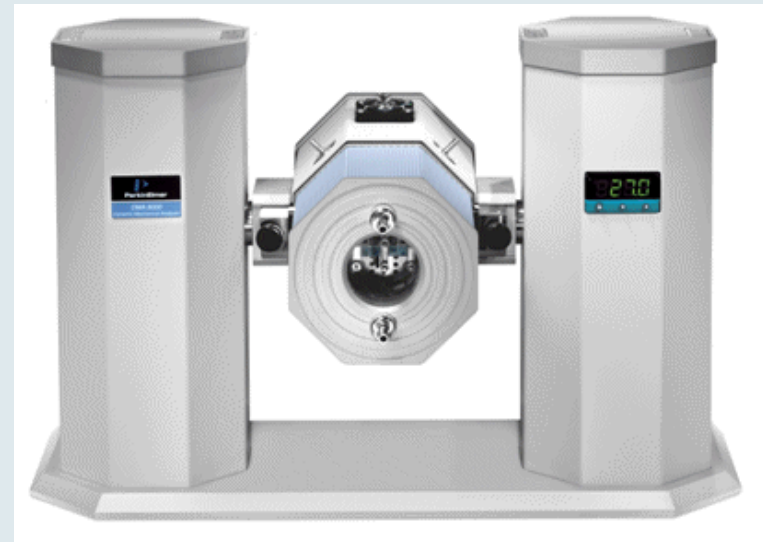
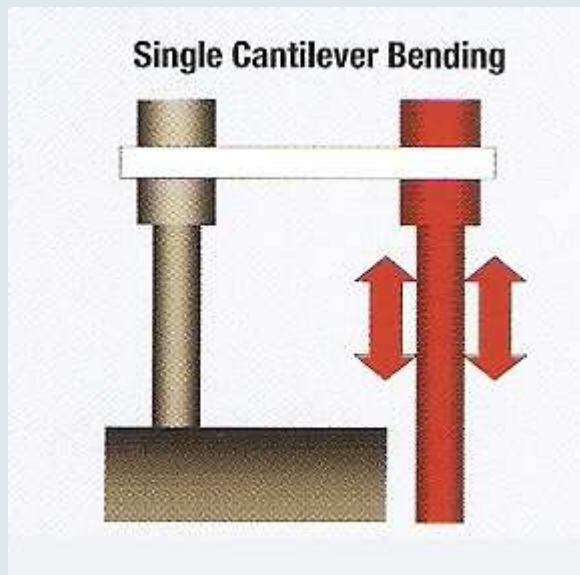


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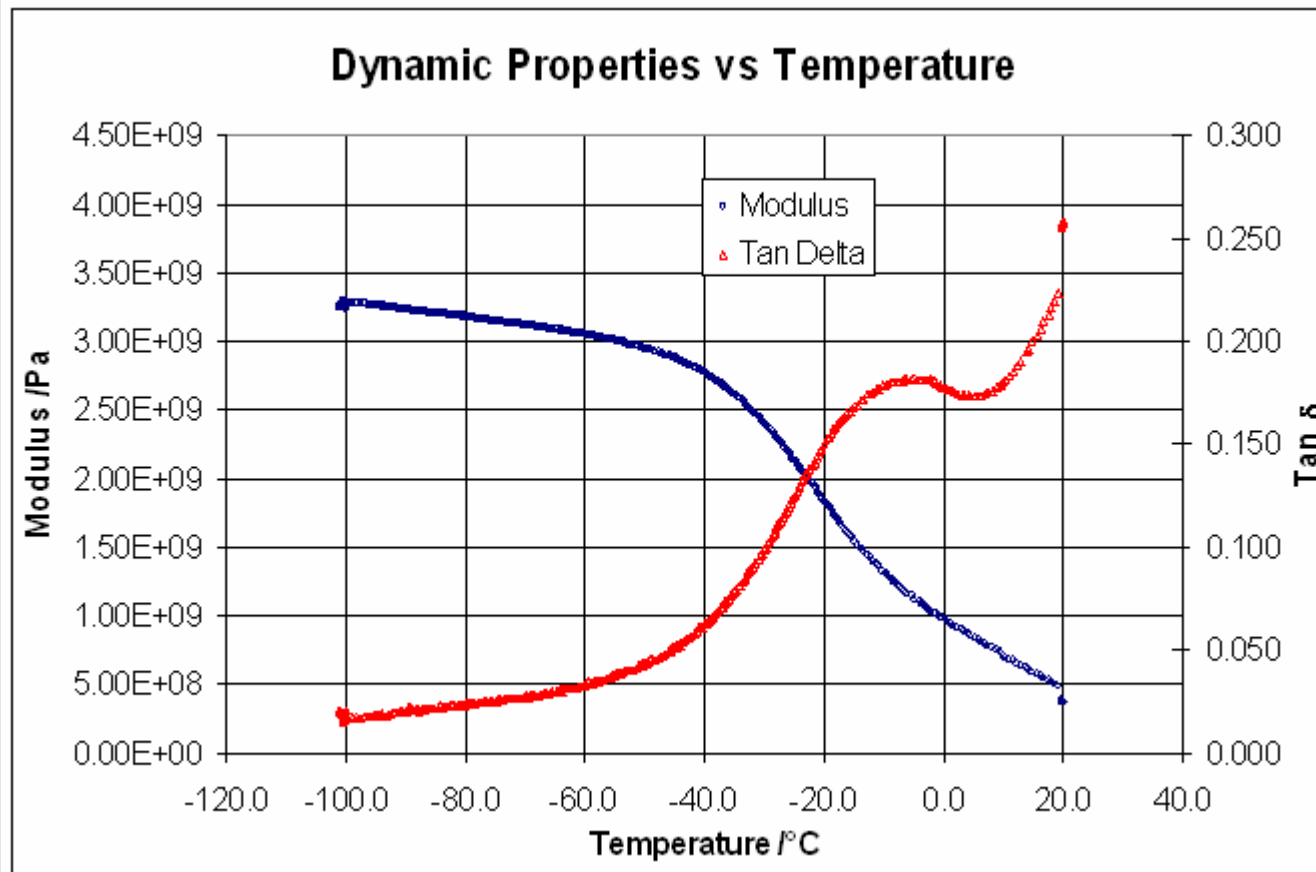
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# DMA Analysis

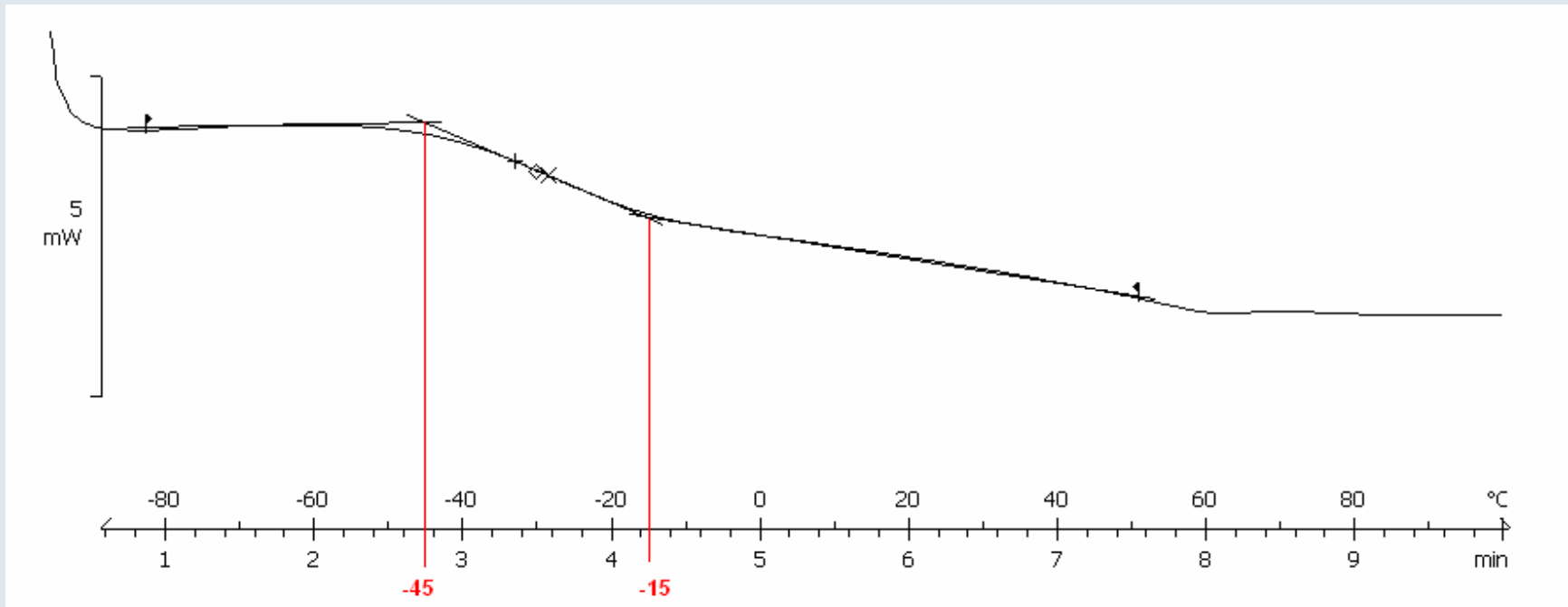
- DMA
- Temperature range  $-100$   $+20^{\circ}\text{C}$
- Heating Rate  $5^{\circ}\text{C}/\text{min}$
- Geometry Single Cantilever Bend
- Frequency 1Hz



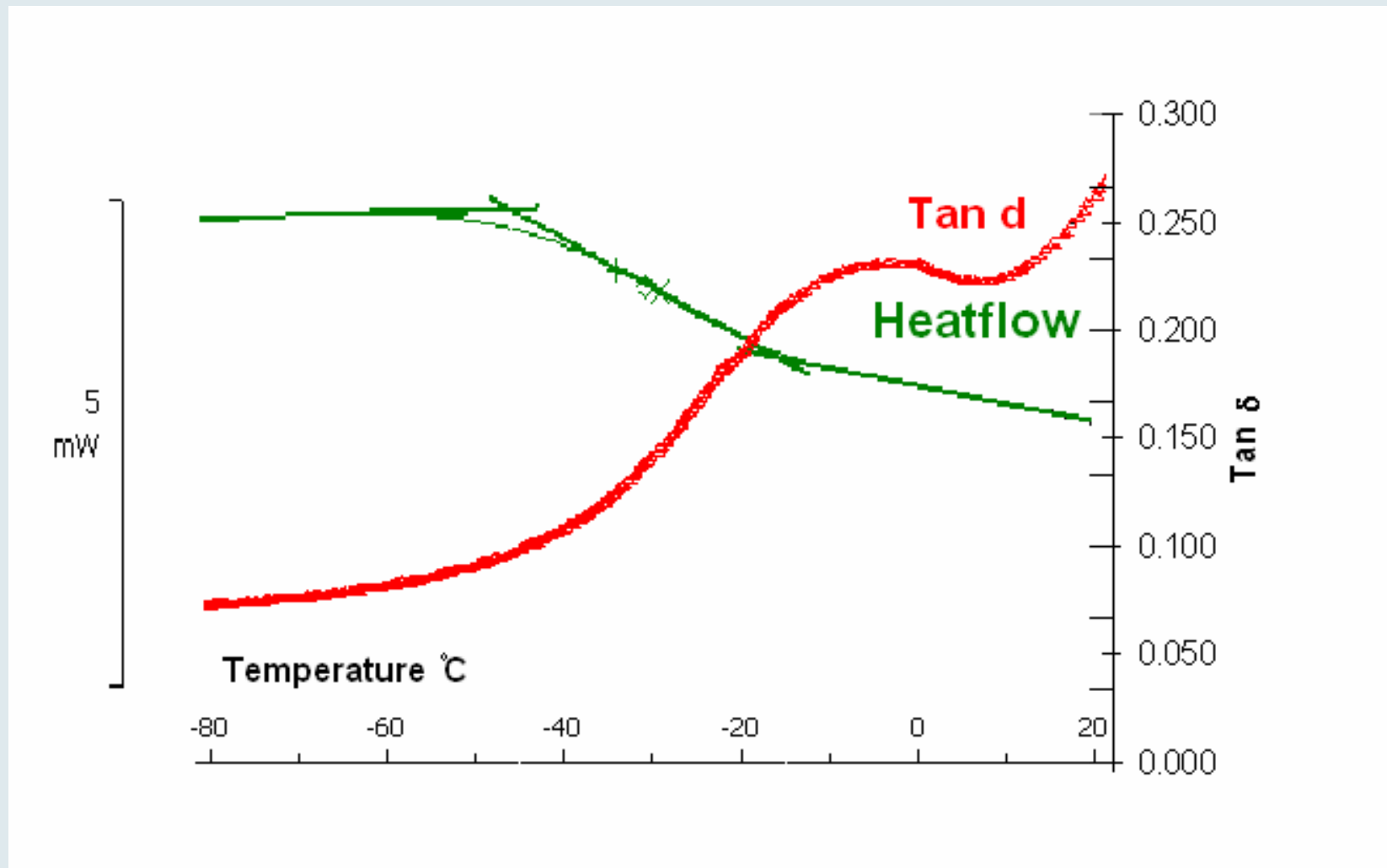
# DMA Results



# DSC Results



# DMA and DSC Results



# Future Work

- Determine the effect of repeated extrusion
- Investigate the effects of plasticisers using thin films
- Investigate the effect of ageing

# Acknowledgements

The Authors would like to thank:

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# Questions

