**POLYMER-MFT INTERACTIONS: FROM SURFACE CHEMISTRY TO RHEOLOGY**

**RESEARCH APPROACH**

**Baseline data on MFTs**
- 3 Contrasting MFTs with diverse organic matter and process history

**Polymer dosage and mixing**

**Polymer flocculated MFTS**

- Rheology
- Spectroscopy
- Thermal Analysis
- Mineralogy
- Chemistry

**Net water release**
- Supernatant Analysis

**DR-FTIR**
- Wave Numbers (cm⁻¹)

**TGA**
- Mass Loss, %
- Temperature, °C

**Rheology**
- G' and G'', Pa

**Shear Strain, %**
Knowledge Gap:
Because of the complexity of MFT, it is not clear what solid phases polymeric flocculants interact with. Possibilities include oil sands clay minerals, bitumen coated MFT particles, and/or free bitumen.
FTIR COMPARISON OF u-MFT WITH POLYMER FLOCCULATED f-MFT

Spectra reflect the bitumen associated with (e.g., coating) the MFT minerals.

Polymer flocculation results in redistribution of bitumen and overall increase in the coating of MFT particles for MFT 2 and MFT 3.
Thermograms reflect the bitumen content of treated and untreated MFT

Polymer flocculation results in redistribution of bitumen and overall increase in the bitumen content of the MFT particles (MFT2 & MFT3). The FTIR and TGA data suggest that polymer may have surfactant like properties.
RHEOLOGY OF POLYMER FLOCCULATED MFTs (f-MFTs)

TESTING APPROACH

- Testing over time (increasing CWR)
- Shear rate ramps $\rightarrow$ YIELD STRESS and VISCOSITY
- Amplitude sweeps & time sweep tests $\rightarrow$ VISCOELASTIC PROPERTIES as f(strain & time)
- INTACT polymer treated MFT
- Effect of pre-shear stages $\rightarrow$ (DISTURBED to REMOLDED behavior)
- Untreated MFT used as baseline

Rheology as an integrator of the overall changes in particle-particle interactions
IMPROVEMENT IN MECHANICAL RESPONSE WITH POLYMER FLOCCULATION

**Graph 1:**
- **Yield stress, Pa** vs. CWR
- **Intact f-MFT 1**
- **Untreated MFT 1**

**Graph 2:**
- **G'_0, Pa** vs. CWR
- **Intact f-MFT 1**
- **Untreated MFT 1**
IMPROVEMENT IN MECHANICAL RESPONSE WITH POLYMER FLOCCULATION

**Graph:**

- **Y-axis:** $G'_{0}$ (Pa)
- **X-axis:** CWR

- **Data Points:**
  - Untreated MFTs
  - Intact f-MFTs

- **Legend:**
  - MFT 1
  - MFT 2
  - MFT 3
- Large linear threshold
- “Solid” like behavior up to large strains
- Polymer treatment effects:
  - Increased stiffness
  - Increased damping
  - Increased cross-over strain

→ REORGANIZATION OF CLAY-WATER SYSTEM AT PARTICLE LEVEL AS A RESULT OF POLYMER NETWORKING EFFECT
SENSITIVITY OF POLYMER f-MFTs

Yield stress, Pa

CWR

Intact f-MFT 1
Remolded f-MFT 1
Untreated MFT 1

G', Pa

CWR

Intact f-MFT 1
Remolded f-MFT 1
Untreated MFT 1
SENSITIVITY OF POLYMER f-MFTs

![Graph showing G' and G'' vs. Shear Strain for Intact f-MFT 1 (CWR=42.5%) and Untreated MFT 1 (CWR=40%).]
SENSITIVITY OF POLYMER f-MFTs

Shear Strain (%)

Shear time, min

G' and G'', Pa

Intact f-MFT 1

CWR=42.5%

CWR=58.9%

CWR=42.5%

CWR=64.0%
STRUCTURE REBUILDING IN POLYMER f-MFTs

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![Graphs showing the relationship between time and G' for different samples](image)
FINAL THOUGHTS

• Our study has tried to integrate surface chemistry with rheological characteristics, while maintaining the complexity of field conditions.

• Not all MFTs are created equal nor do they respond in the same manner to polymer flocculation.

• Polymer flocculation induced significant changes in the surface character of the MFTs.

• While exhibiting increased strength and stiffness at the same CWR, polymer flocculated clays are characterized by great sensitivity.

• Significant degradation of the response occurs as a result of shearing, and the rate at which structure build up processes occur is greatly reduced relative to untreated MFTs.
ACKNOWLEDGEMENTS
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POLYMER EFFECTS

![Graph showing G' and G'' vs. Shear Strain, % for Intact f-MFT 1 (CWR=42.5%) and Untreated MFT 1 (CWR=40%).]

![Graph showing G', Pa vs. G'', Pa with logarithmic scales.]