Investigation of Sunflower Dust Properties that Contribute to Combine Fires

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Outline

- Introduction
- Laboratory Testing
  - Started May 2011
- Results
- Conclusion
- Future Work

Introduction

Background

- Harvesting sunflowers lead to fires on combines
- More sunflower related fires than other crops

Project Goals

1. Analyze physical and chemical properties of dust
2. Locate source of sunflower dust

Laboratory Testing

Dust sample preparation

- Sunflower and corn stover plants
- Milling stage with attached vacuum
- Particle separation stage using sieves

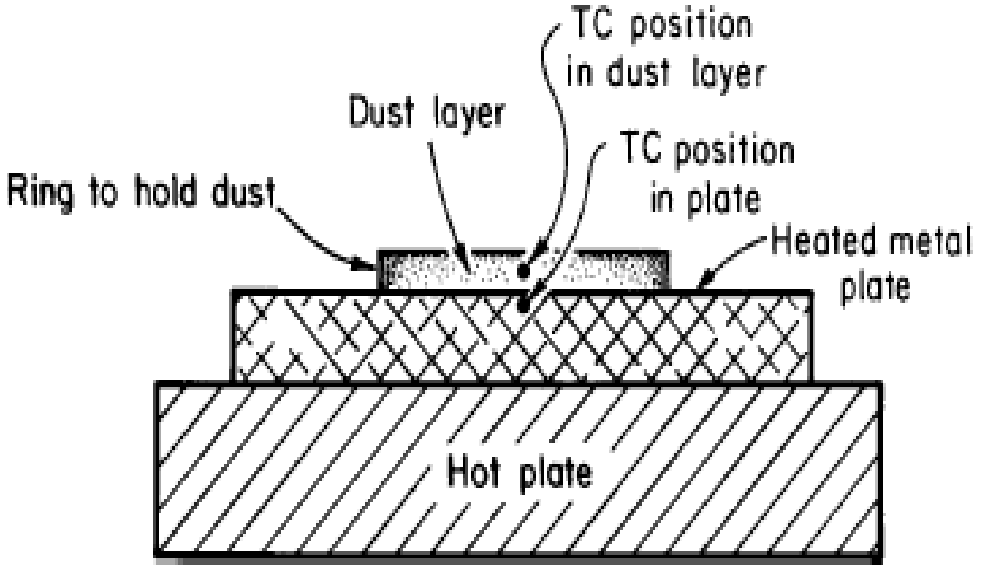
Mesh #	Particle Size (µm)
50	710-300
100	300-150
230	150-63
500	63-25

(1 mm = 1000 µm)

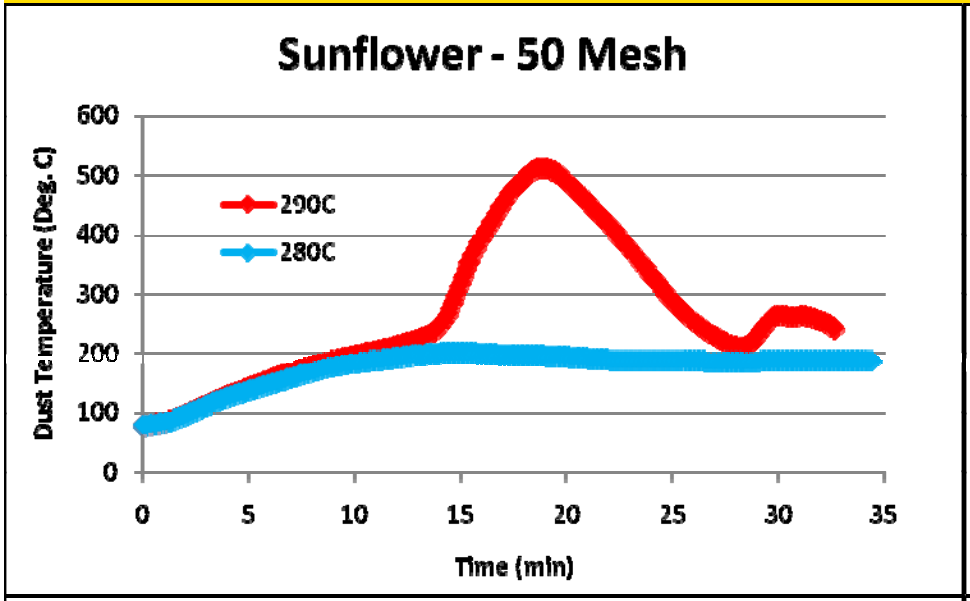
Laboratory Testing

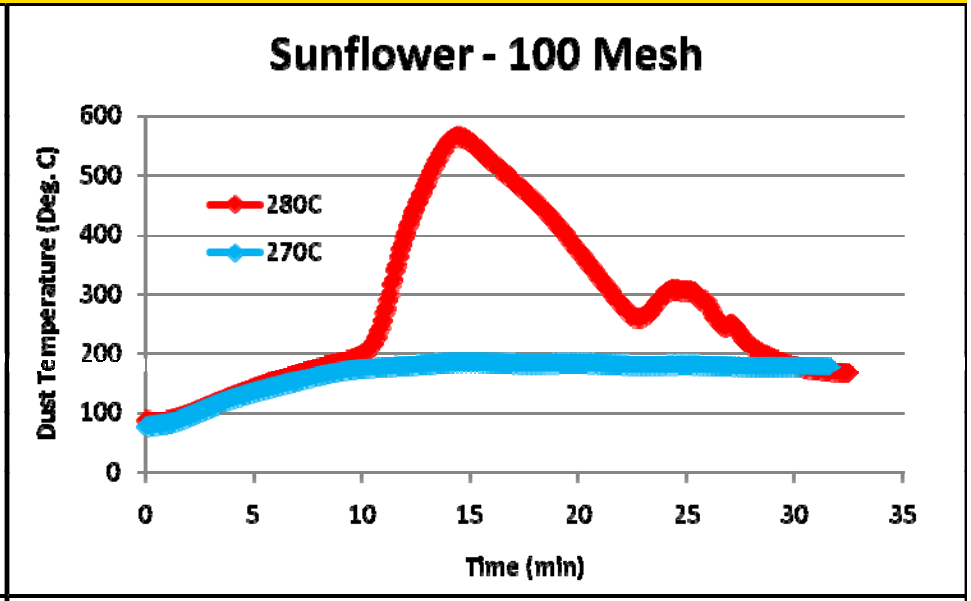
Ignition point of dust layers

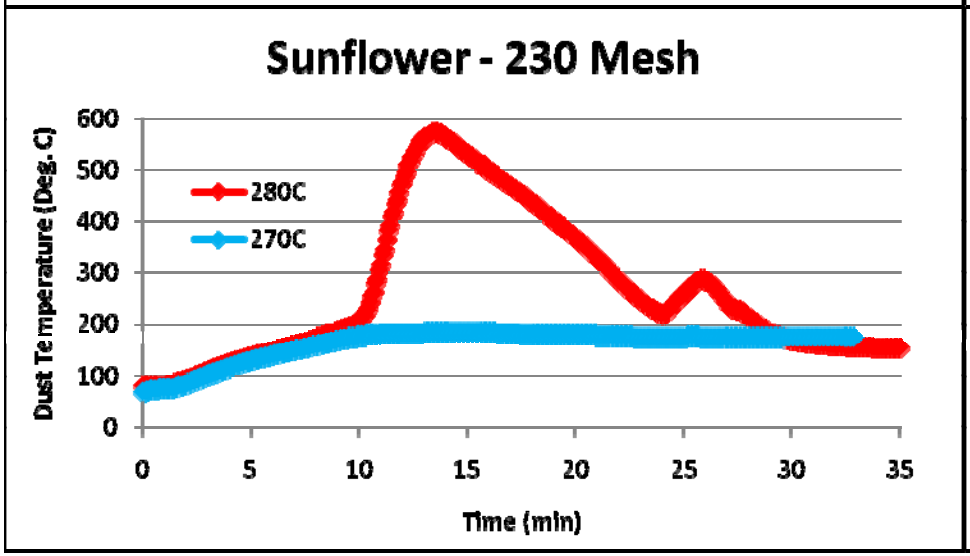
- Hot Plate Apparatus

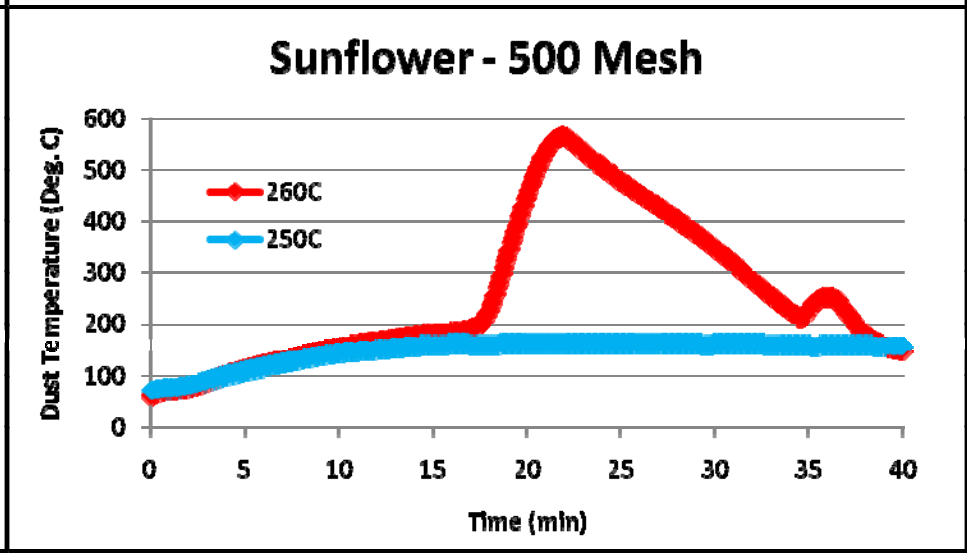


Ignition Point Results









Ignition Point Results

Mesh #	Particle Size (µm)	Corn Stover		Sunflower	
		Ignition Point (Deg. C)	Ignition Point (Deg. F)	Ignition Point (Deg. C)	Ignition Point (Deg. F)
50	710-300	320	608	290	554
100	300-150	310	590	280	536
230	150-63	310	590	280	536
500	63-25	290	554	260	500

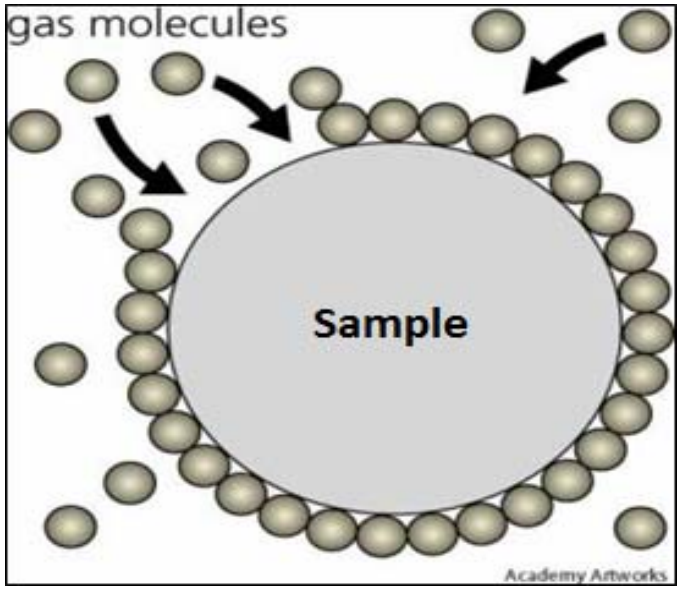
- Smaller particle sizes exhibit lower ignition points
- Sunflower dust has lower ignition point by 30°C at every particle size
- Collaborating farmers supplied field samples during 2011 sunflower harvest fires

Collected Field Sample	280°C	536°F

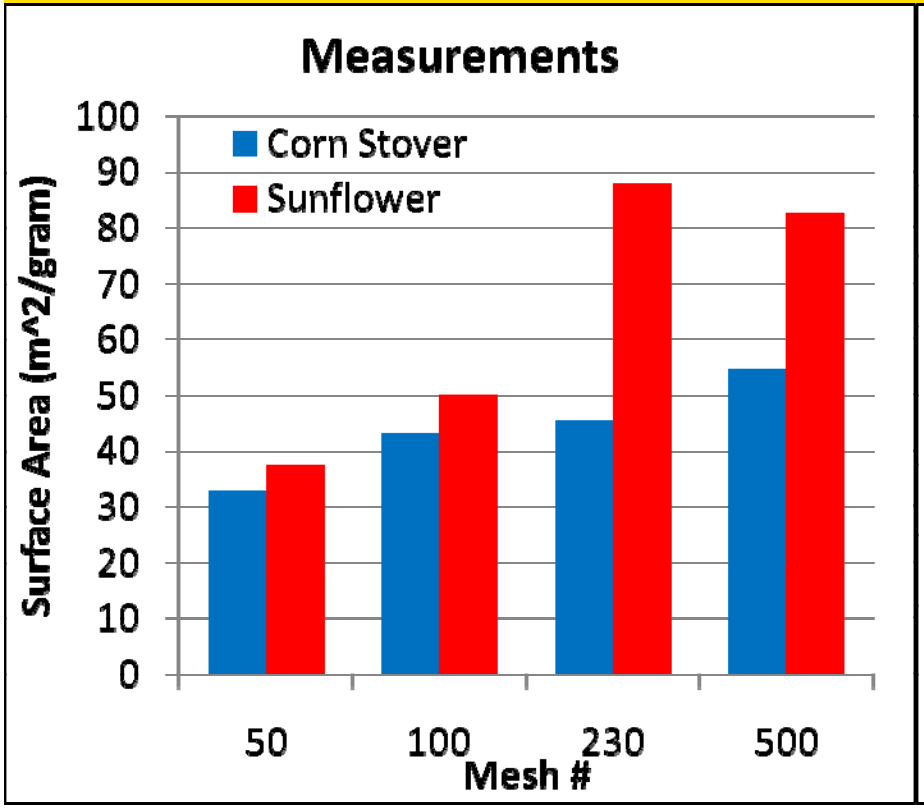
Physical Properties

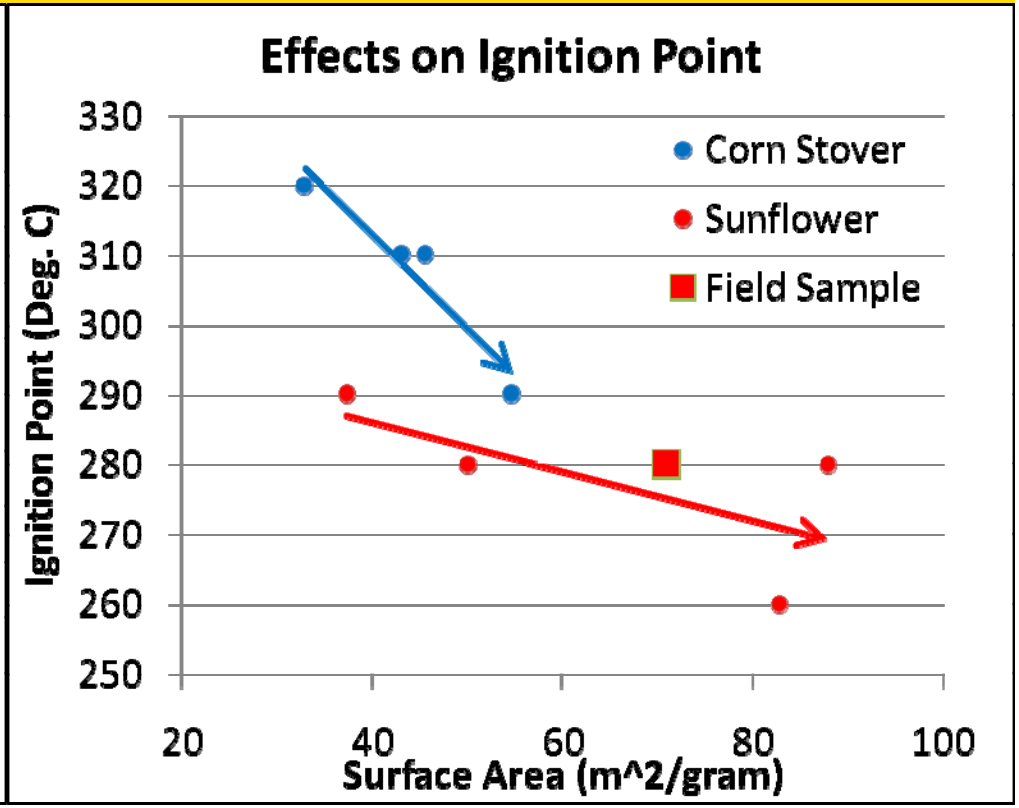
Physical Adsorption

- Micromeritics Accelerated Surface Area and Porosimetry Analyzer (ASAP)
- Nitrogen gas molecules adsorb to particle surface
  - Measures surface area and total pore volume



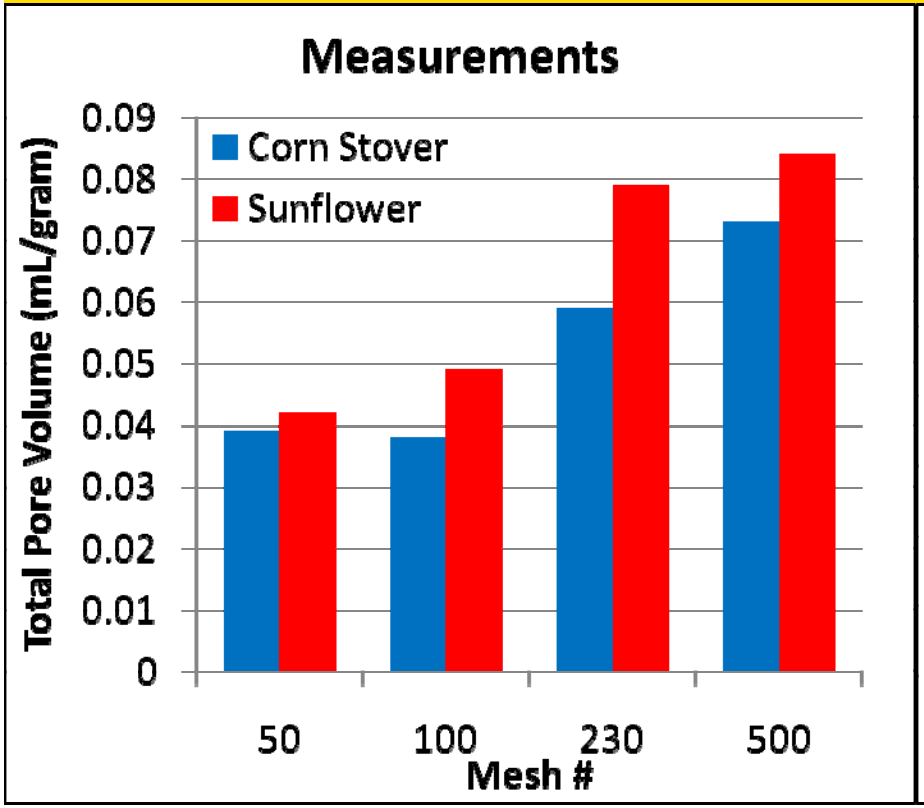
Surface Area

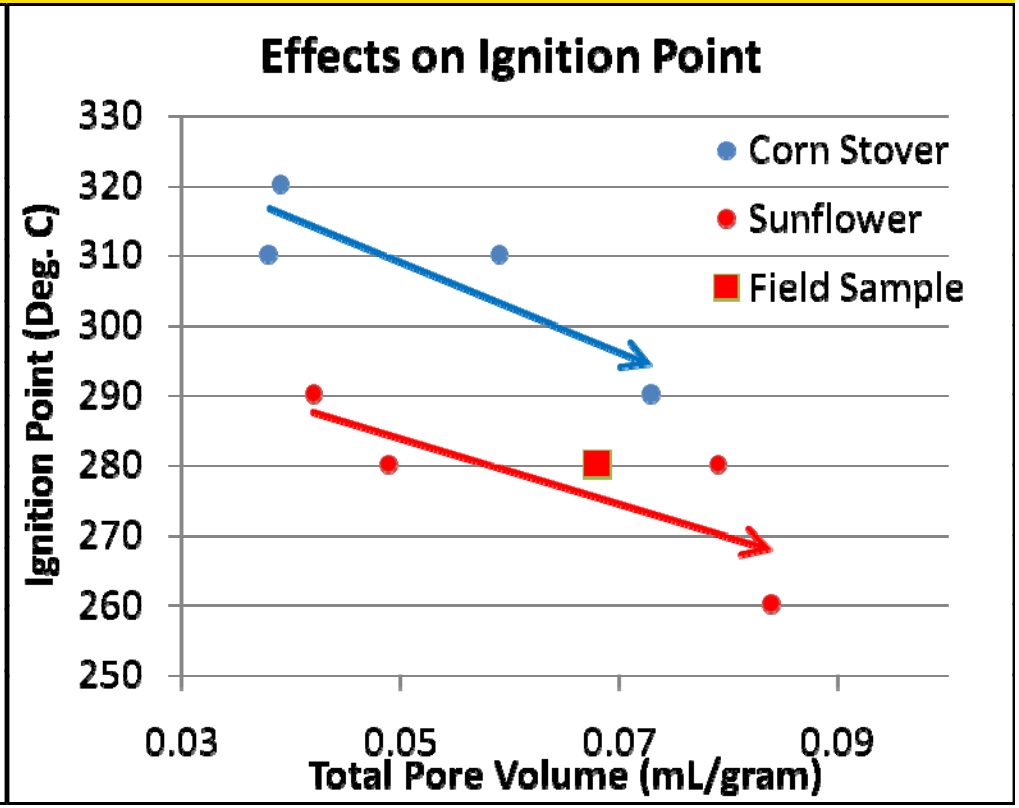




- Sunflower dust has higher surface area
- Higher surface area allows for higher heat transfer and lowers ignition point

Total Pore Volume





- Sunflower dust has higher total pore volume
- Higher pore volume allows more air closer to particle surface

2nd Project Goal

What sunflower parts are responsible for generating dust?

Chemical Properties

- Volatile Organic Compounds (VOC's) and Ash (Minerals) Composition

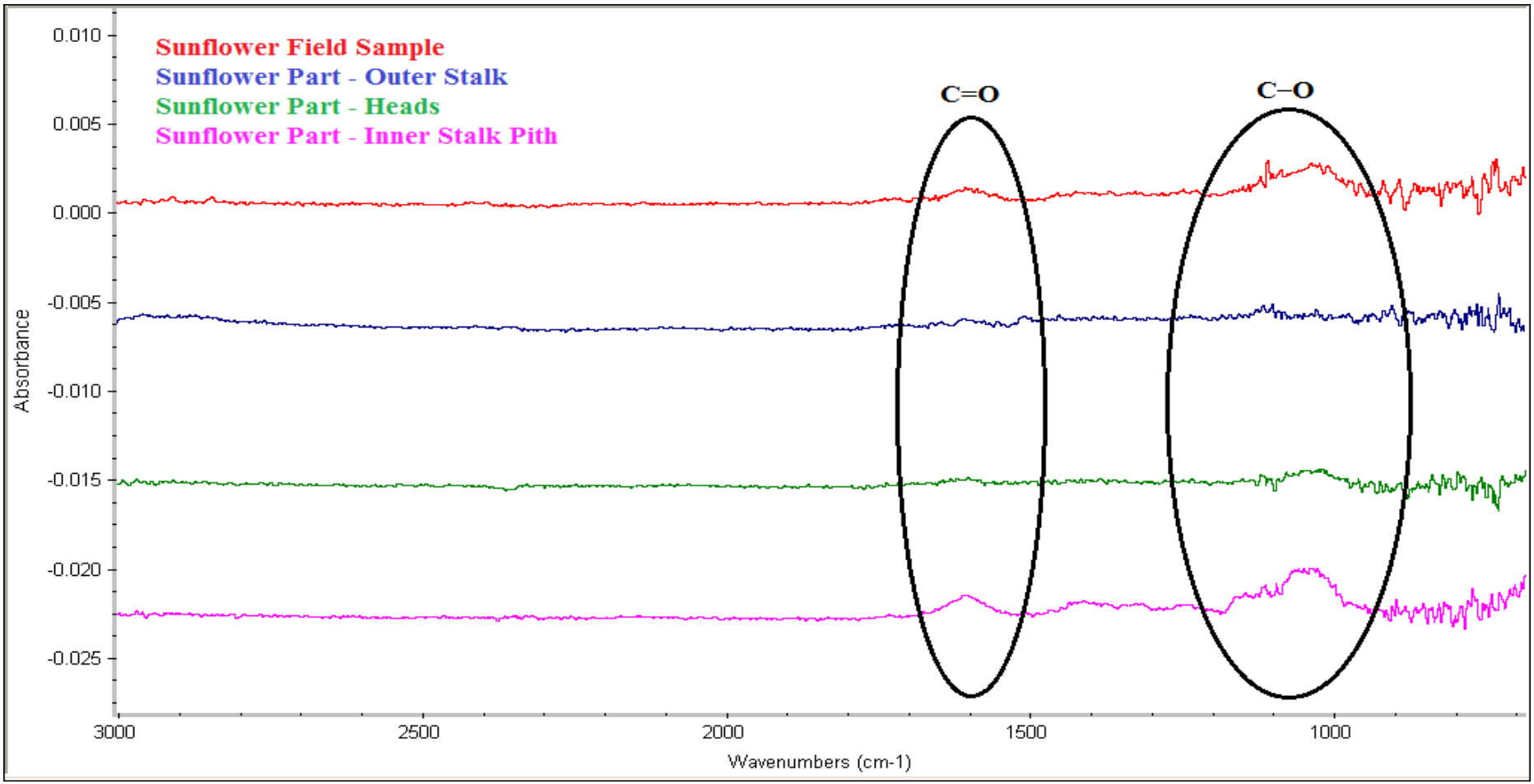
Part of Sunflower	Average Volatile %	Average Ash %
Outer Stalk	77.72	4.23
Whole Heads	79.44	6.56
Inner Stalk (Pith)	75.45	11.17
Collected Field Sample	76.45	13.58

Chemical Structure

Fourier Transform Infrared Spectroscopy (FTIR)

- Analyzes chemical bond structure on particle's surface
- Plants primarily consist of Carbon and Oxygen
- Focus on C=O and C–O bonds

FTIR – Sunflower Comparison



- Field sample most similar to inner stalk pith material

Conclusion

- Sunflower dust has lower ignition points than corn stover
  - Higher surface area
  - Higher total pore volume

- Inner stalk pith material appears to be source of field sample dust
  - Volatile and ash content are similar
  - FTIR indicates similar amount of C=O and C–O bonds

Future Work

- Air suspended dust test
  - Ignition point of dust flowing in air
- Static electric spark test
  - Minimum electrical energy required for ignition
  - Dust layers and air suspended dust
- Develop solution to help reduce combine fires
  - Based on final understandings of dust ignition characteristics
- Started as single year study on sunflower dust

Acknowledgements

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Thank You
Any Questions?