

DETERMINING THE FEASIBILITY OF CHEMICAL IMAGING OF COTTON TRASH

Chanel Fortier

James Rodgers

ARS-USDA-SRRC-CSQ

New Orleans, LA

Abstract

Cotton trash has become comingled with cotton lint causing greater interest in the textile community. Currently, trash is identified visually by human “classers” and instrumentally by the Advanced Fiber Information System (AFIS) and the High Volume Instrument (HVI). Although these methods can be successfully used to examine cotton trash, the “classer” method is subjective and is affected by human error within and between “classers” while the AFIS and HVI methods do not yield specificity in the identity of cotton trash types. Previously, it has been demonstrated that spectroscopic analysis of cotton trash yields information about the origin of the cotton trash. In the current study, chemical imaging was used to depict cotton trash and yielded promising qualitative information of select trash types.

Introduction

Botanical trash refers to the plant parts of the cotton plant (e.g. hull, leaf, seed coat, and stem) excluding cotton lint. During harvesting, cotton lint can become co-mingled with botanical trash. Furthermore, during ginning, most of the cotton trash becomes pulverized into dust making it difficult to determine the trash’s origin in the presence of cotton lint. If the trash containing-cotton lint survives to the spinning stage, cotton trash present causes “ends down” in yarn. The quality of cotton lint from a global perspective can be negatively affected because trash co-mingled with it affects its marketability.

Previously, pure component cotton trash types have been identified with Mid-Infrared and Near-Infrared spectroscopy (Himmelsbach et al., 2006 and Fortier et al., 2010). However, there is interest in determining the distribution and identity of cotton trash in cotton samples. Recently, a new technique has emerged which can yield this information—chemical imaging. Chemical imaging, also known as hyperspectral imaging, can yield qualitative and quantitative information, which can be advantageous to the textile community as an identification technique in relation to the trash present with cotton lint. The spatial information is contained on the x- and y-axes, while the z-axis contains the spectral information. Each pixel in the chemical image has a specific spectrum associated with it. The data is then compiled in a data cube where integration can be used over a specific spectral region to generate the chemical image. With the advent of focal plane array detectors, data acquisitions can now take place over a reasonable time frame. It is the goal of this research to analyze trash comingled with cotton lint.

Methods

Pure cotton balls that were previously scoured and bleached were used in this study. Figure 1 shows the experimental setup of the FT-IR spectrometer (Bruker Optics). The FT-IR spectrometer is fitted with an Attenuated Total Reflectance (ATR) accessory in the Imaging Macro-chamber (IMAC) sample holder as shown in Figure 2. To prepare the sample for analysis, the trash was added onto zinc-selenide crystal. Next, the cotton was placed on top of the trash. Finally, the clamp was screwed down to ensure good contact of the sample with the crystal. The spectral resolution was 8 cm^{-1} with 16 background scans and 16 sample scans each. The spectral range scanned was 900 cm^{-1} to 4000 cm^{-1} . In addition, leaf trash was manually added to the cotton sample.

Results

Figure 3 depicts a chemical, hyperspectral image of cotton comingled with leaf and hull trash types. The colors in the image correspond to the three component sample, (hull trash, cotton, and leaf trash). In the chemical image, dark blue corresponds to hull trash, lime green corresponds to cotton, and pink and red correspond to leaf trash. The representative spectra are shown in Figures 3, 4, and 5. The three component sample image was identified based on their similarity with the pure component absorbance spectra. When observing the pure component spectra, there are some regions that are distinctive for cotton, leaf and hull trash. When identifying trash from cotton, the cotton has a distinctive doublet OH stretching band at $3200\text{--}3300\text{ cm}^{-1}$. In contrast, the trash types have a singlet over this same

region. When comparing the fingerprint regions of all three components from 1700 to 900cm^{-1} , leaf trash is very characteristic with a triplet peak at $1500\text{-}1000\text{cm}^{-1}$, hull has a quadruplet band over $1500\text{-}1000\text{cm}^{-1}$, and cotton has a unique set of bands corresponding to the CO stretching region. The differences in chemical imaging is also a function of reflectance and refractive index properties in the three component sample. Overall, the chemical imaging technique shows promise in the identification of cotton trash commingled with cotton lint.



Figure 1. FT-IR imaging spectrometer.



Figure 2. ATR accessory in the IMAC sample holder

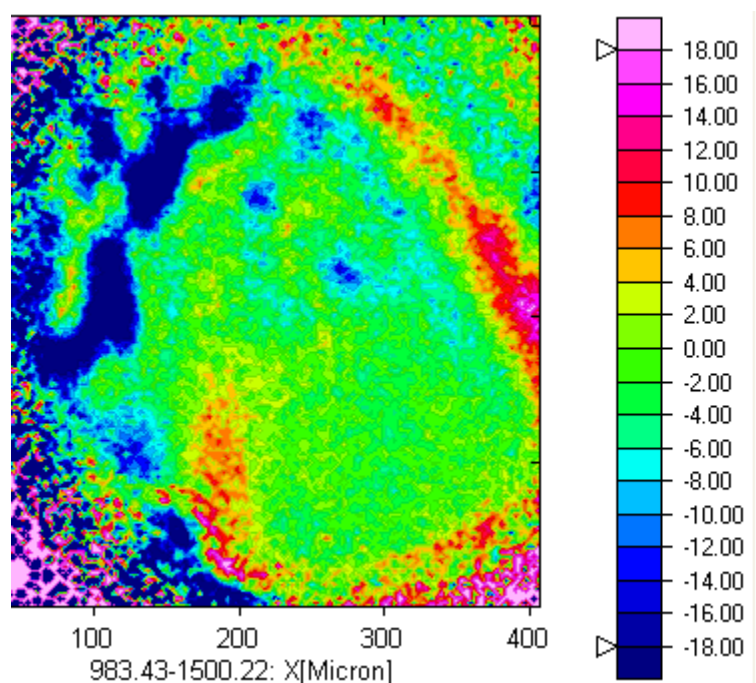


Figure 3. Chemical hyperspectral image of hull and leaf trash types commingled with cotton lint. Red and pink = leaf trash, lime green = cotton, and dark blue = hull trash.

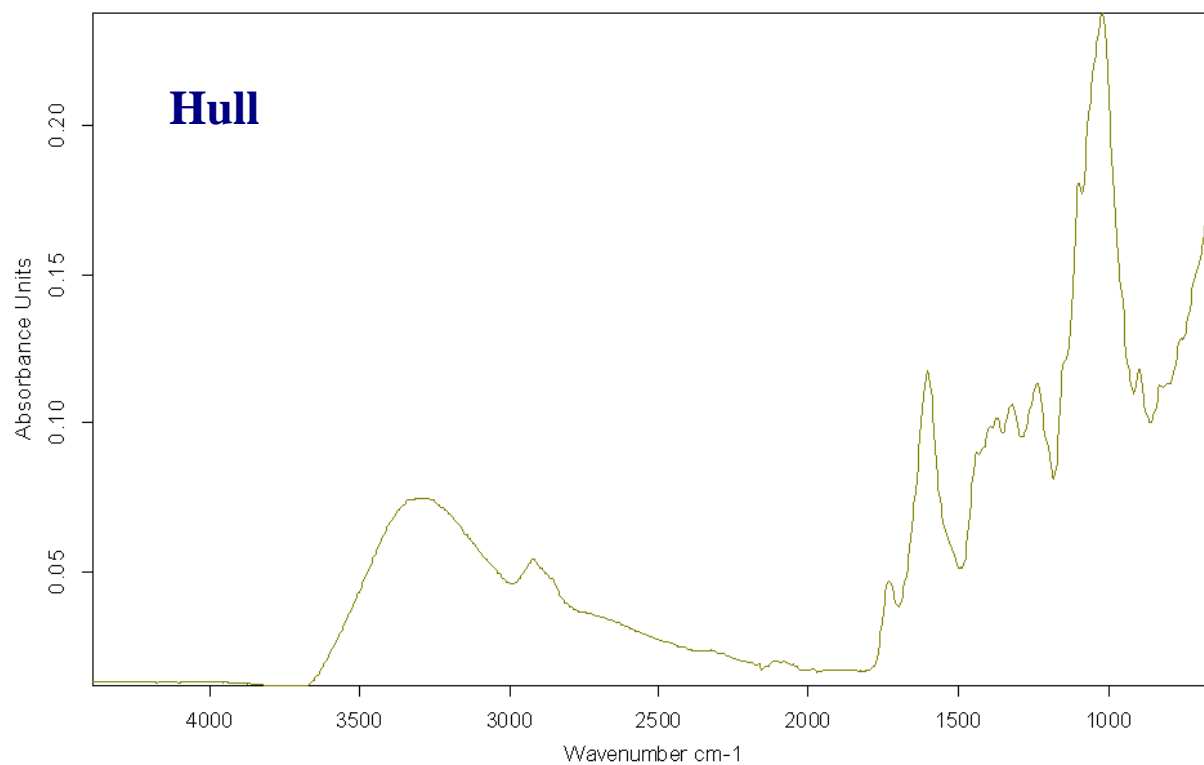


Figure 4. Representative ATR-FTIR absorbance spectrum for hull trash.

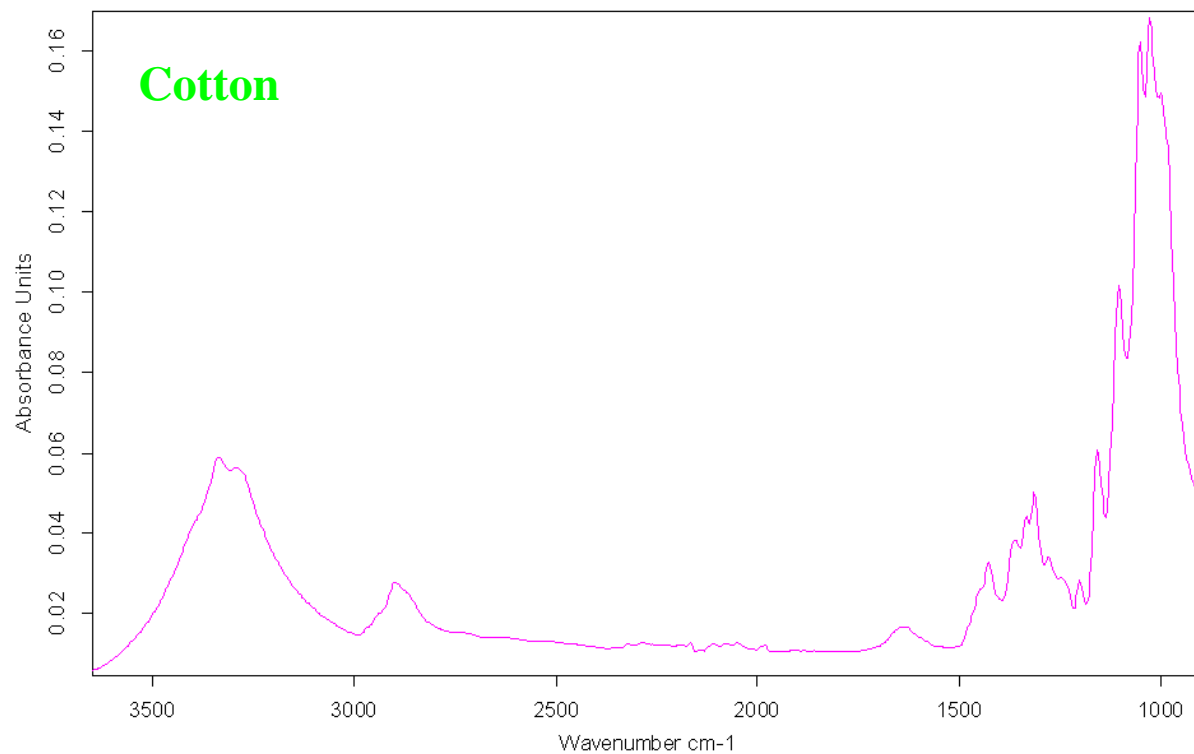


Figure 5. Representative ATR-FTIR absorbance spectrum for cotton lint.

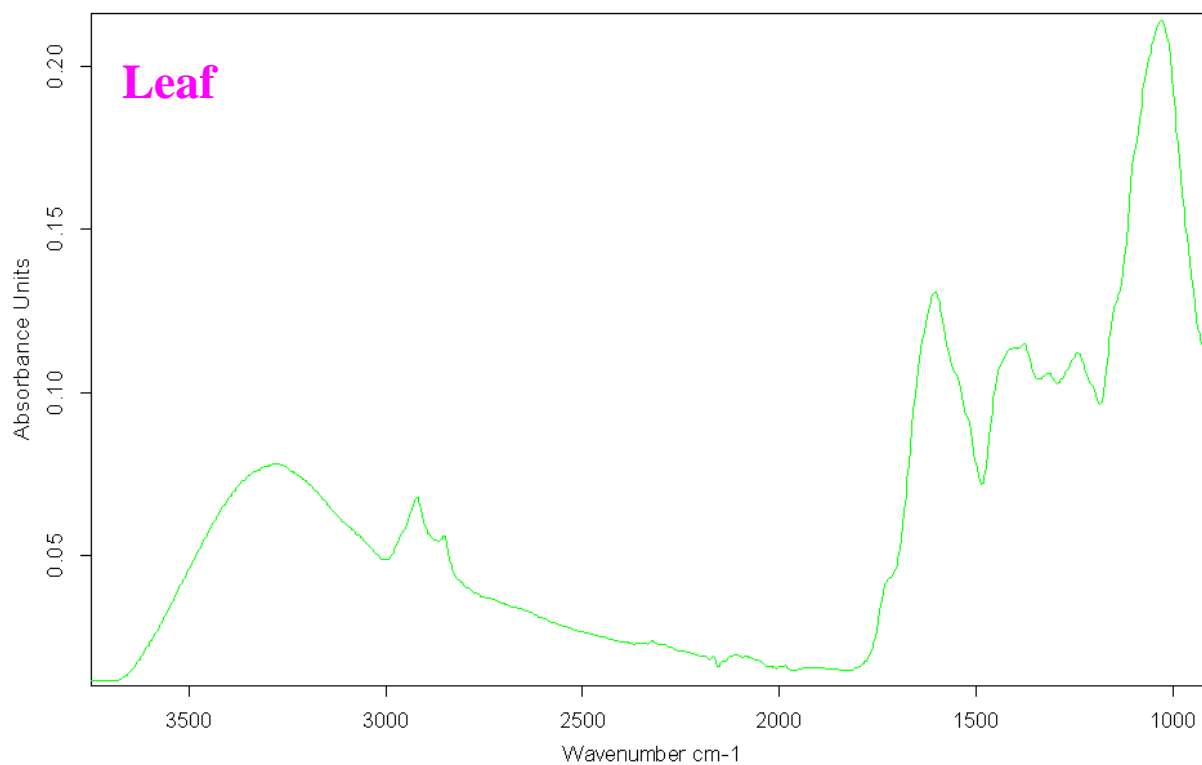


Figure 6. Representative ATR-FTIR absorbance spectrum for leaf trash.

Conclusions

Chemical imaging was evaluated for its potential to identify cotton lint comingled with leaf and hull trash. The technique was accurate and required minimal sample preparation owing to the use of an ATR accessory and focal plane array detector. Cotton, leaf, and hull trash identity was confirmed using previously published spectral libraries. The fingerprint (900-1500 cm^{-1}) and OH stretching (3200-3000 cm^{-1}) regions matched the cotton lint and leaf and hull trash very closely. Thus, a “proof of concept” has been established which shows the feasibility and promise of this study.

References

- Fortier, C., J. Rodgers, M. Santiago Cintron, X. Cui, J. Foulk. 2010. Identification of Cotton and Cotton Trash Components by Fourier Transform Near-Infrared Spectroscopy. *Textil. Res. J.* 81:230-238.
- Himmelsbach, D., J. Hellgeth, D. McAlister. 2006. Development and Use of an Attenuated Total Reflectance/Fourier Transform Infrared (ATR-FTIR) Spectral Database to Identify Foreign Matter in Cotton. *J. Agric. And Food Chem.* 54:7405-7412.

Disclaimer

The use of a company or product name is solely for the purpose of providing specific information and does not imply approval or recommendation by the United States Department of Agriculture to the exclusion of others.