Infrared Microscopy of Oral Tissues to Detect Foreign Material

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ABSTRACT

The goal of this research is to demonstrate the ability of infrared microscope technology to detect foreign material in oral tissue biopsies using spectrum signature probing. The chemical map data were then probed with stored material spectra for correlations. In addition to variations between data acquired through reflection or transmission of the infrared beam, differences in the thickness of the sections were observed. Results showed that foreign reference spectra showed varied and more specific correlations than the control reference spectra, a positive linear correlation between tissue thickness and correlation of reference spectra and tissue spectra, and improved resolution of sections in transmission.

INTRODUCTION

❑ Modern pathology reporting of foreign material inclusions is lacking.
❑ A definitive identification of the material present in tissues examined can only be achieved with a chemical signature of that material.
❑ Infrared microscopy mapping of tissue biopsies can augment pathologists understanding of disease etiology in patients.

MATERIALS and METHODS

❑ A single oral tissue biopsy source has been sectioned into three different thicknesses (2, 5, and 10 micrometers).
❑ These three sections have been placed on both coated glass microscope slide and germanium prisms.
❑ Coated glass microscope slides only permits infrared reflection, while germanium prisms allow both infrared reflection and transmission.
❑ Infrared radiation is passed through a fixed set of points within the predetermined map's boundaries. Software in the computer integrates these individual spectra into a chemical map of the tissue section.
❑ It is important to note that the individual spectrum can still be recalled, and that the de-identified tissue section is not altered in anyway during the scanning procedure.
❑ Reference samples of material are scanned, and their spectra are stored within the computer. Software allows material reference spectra to be compared to the individual spectra of the tissue section's chemical map.
❑ The product of this comparison is a correlation map (Figures 2-4), which determines how much the tissue spectra and the reference material spectra correlate.
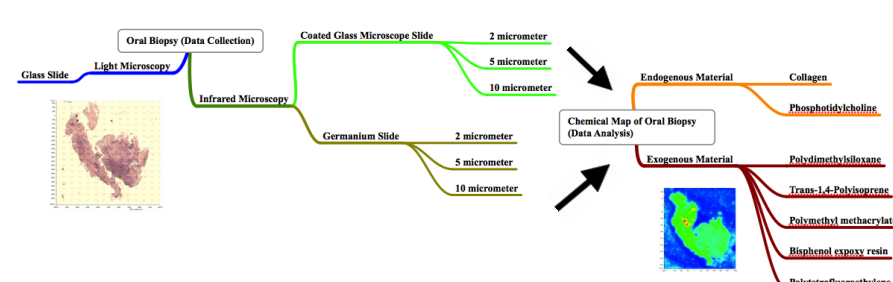

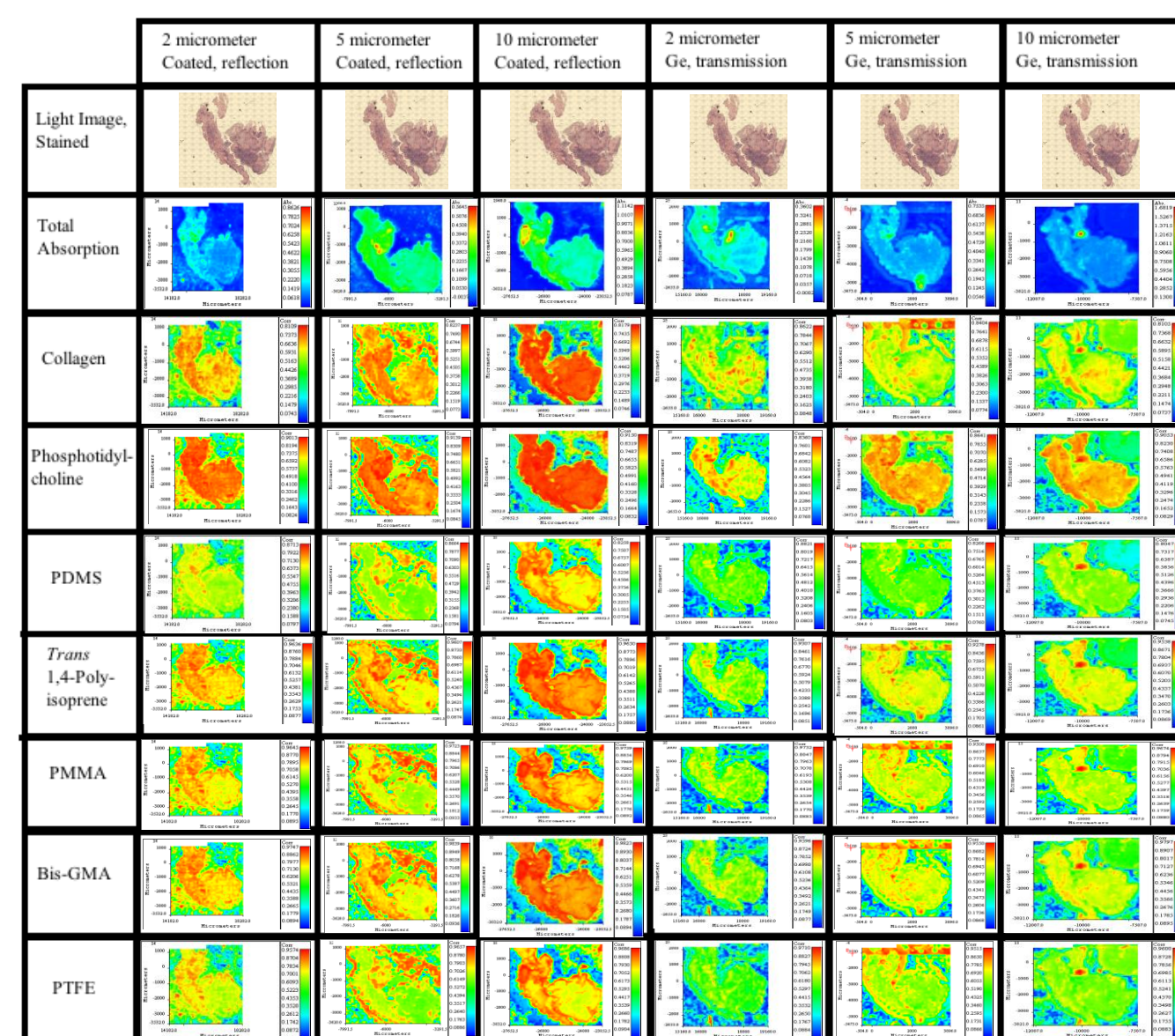Figure 1: Outline of the methods used in this project.

RESULTS

Figure 2: Multiple infrared chemical images of sample 3082414, section A.
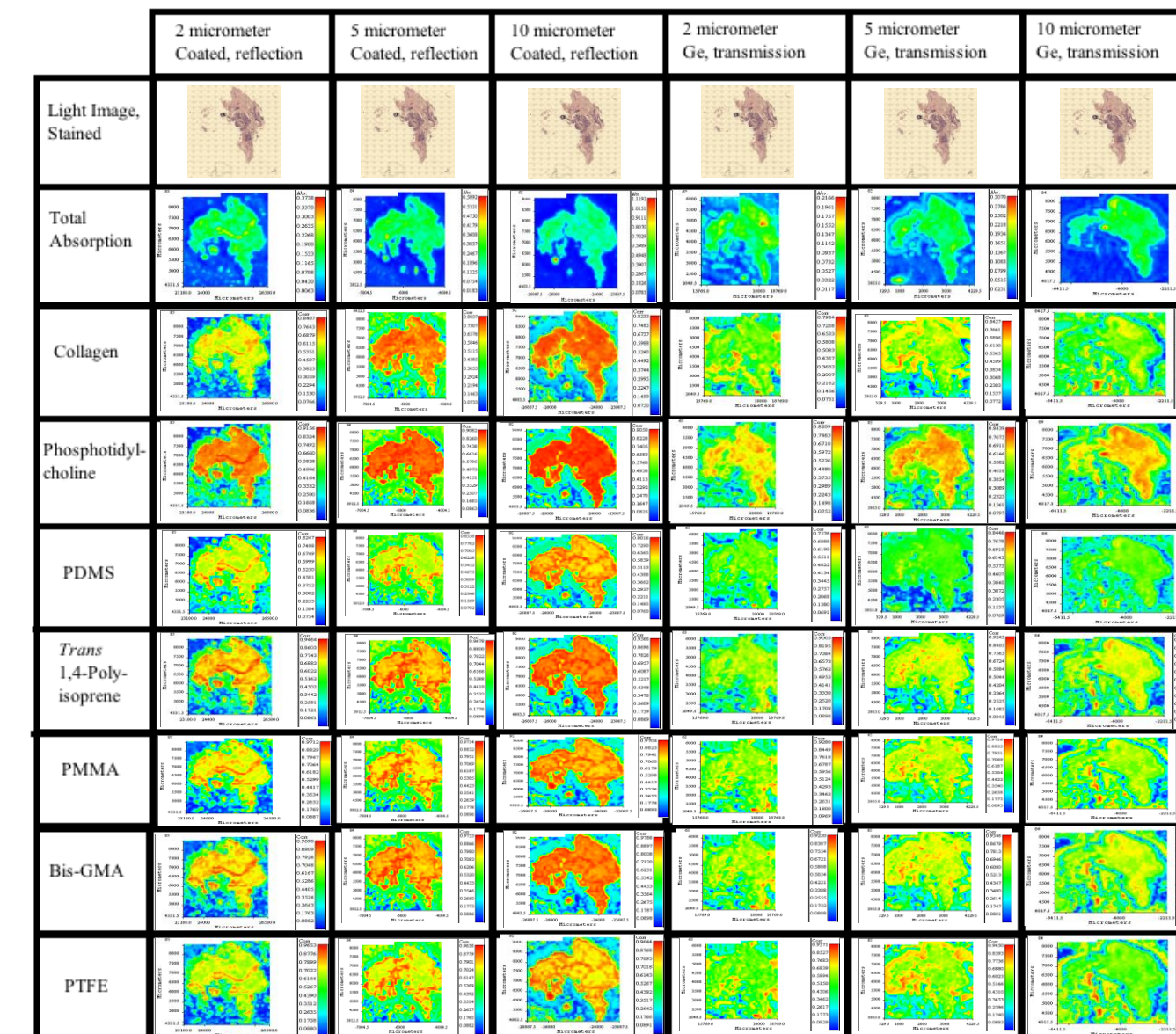

Figure 3: Multiple infrared chemical images of sample 3082414, section B.
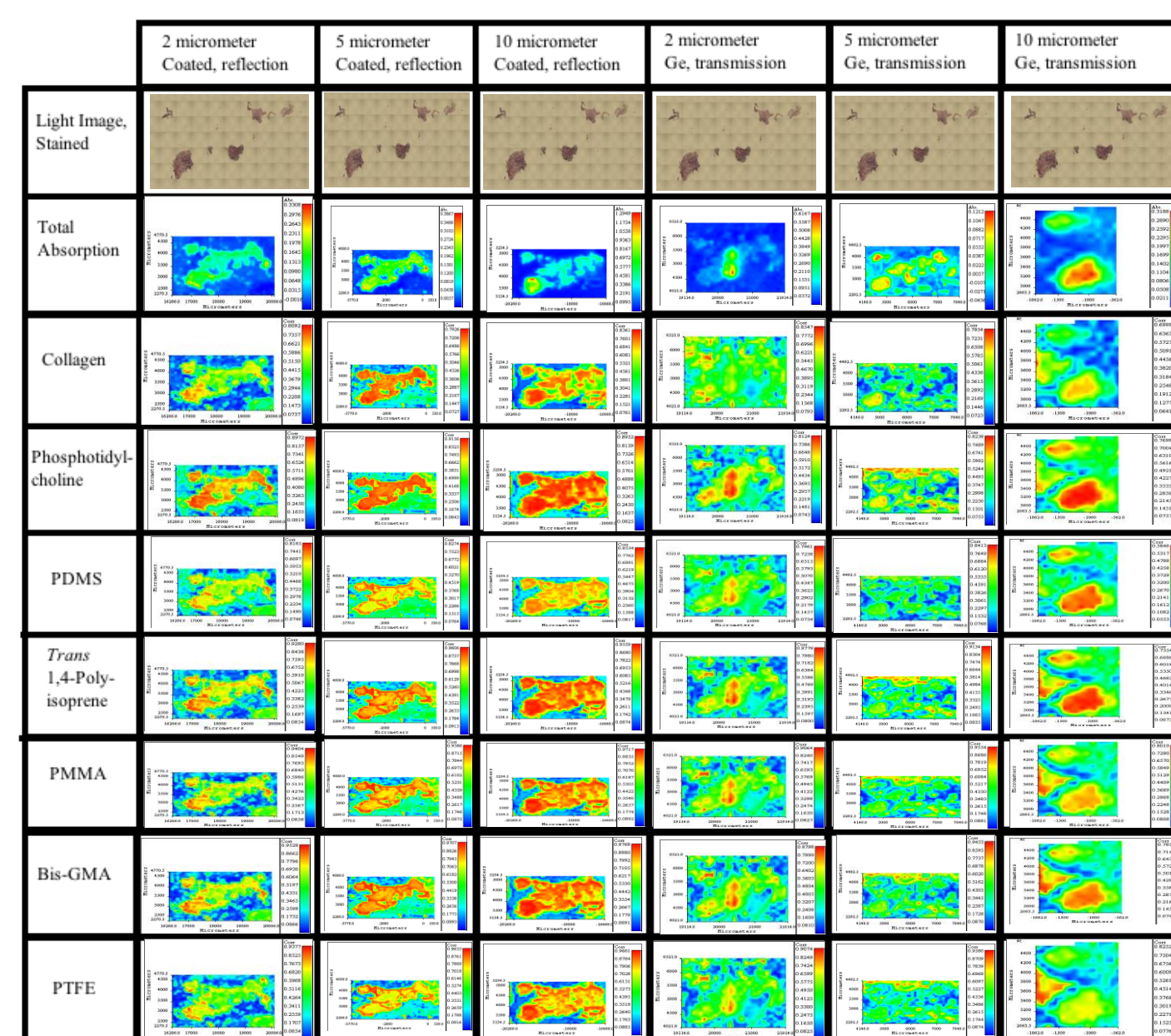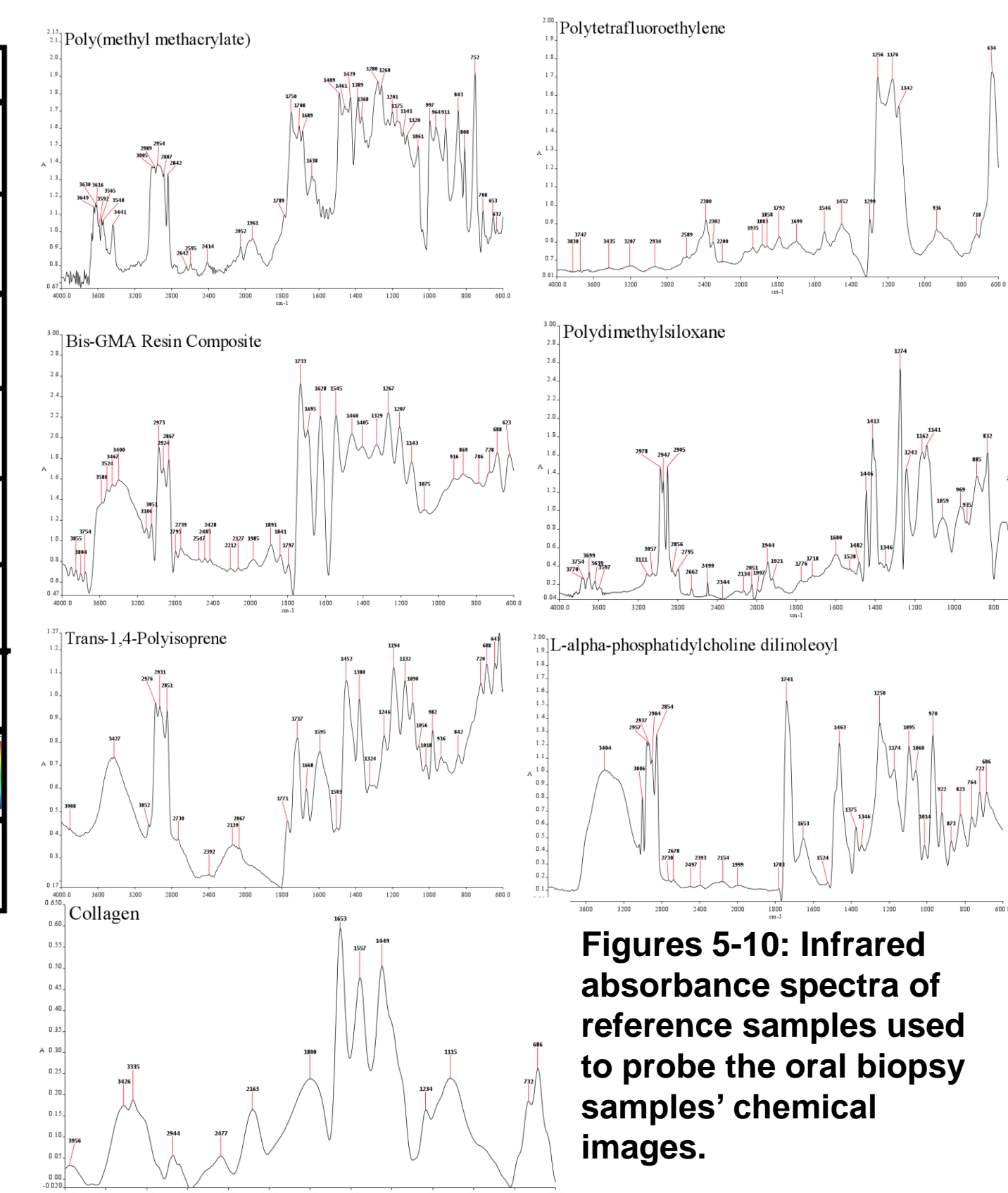

Figure 4: Multiple infrared chemical images of sample 3082414, section C.

Figures 5-10: Infrared absorbance spectra of reference samples used to probe the oral biopsy samples' chemical images.

CONCLUSIONS

❑ Collagen and phosphotidylcholine act as controls in this experiment because of the guaranteed correlation between their spectra and the spectra of the tissue sections. (Figures 2-4; Rows 2-3)
❑ Foreign reference spectra showed varied and more specific correlation than the controls when probed with the oral tissue sections' spectra. (Figures 2-4; Rows 4-8)
  • High correlation between foreign reference spectra and oral tissue biopsy does not necessarily mean there is a high amount of that material in that tissue. It could suggest that the two spectra have high amounts of similar absorbance peaks, for example hydrocarbon.
  • In order to be sure of the presence of foreign material, you can go back and take individual spectra of those high correlation areas to confirm the presence of the material, OR
  • You can also restrict the range of absorbance peaks that you correlate between the reference material spectra and the oral tissue biopsy spectra.
❑ There is a positive correlation between the thickness of the tissue section and the level of correlation between reference spectra, and oral tissue spectra. As tissue section thickness increases, correlation increases.
  • You want the tissue section to be thick enough to see small amounts of foreign material, but you do not want it so thick that any shared absorbance peaks between the two spectra would decrease the resolution, and thus the chance of finding these small amounts of foreign material.
  • Based on these experiments a 10 micrometer section may be too thick to detect foreign material if one is using the entire absorbance range in comparing the reference material and the oral tissue biopsy.
  • Also, 2 or 5 micrometer may be sufficiently thick to detect foreign material in a tissue section.
❑ Biopsy sections analyzed with the infrared beam in transmission showed better resolution than those analyzed with the infrared beam in reflection.
  • Looking at sections of the same thickness, probed with the same reference sample one can see more varied and specific correlation findings within those samples analyzed in transmission.

REFERENCES

1. Griffiths, Peter R., and Haseth James A. De. *Fourier Transform Infrared Spectrometry*. 2nd ed. Hoboken, N.J.: Wiley-Interscience, 2007. *EBooks Corporation*. Web. 15 July 2010.
2. Alberts, Bruce. *Molecular Biology of the Cell. Fifth ed. Garland Science, 2007. Print.Pages 579-585
3. Karp, Gerald. *Cell and Molecular Biology Concepts and Experiments. 5th ed. New York: Wiley, 2007. Print.Pages 728-730
4. N. Baird William J. Rea, Deborah. "The Temporomandibular Joint Implant Controversy: A Review of Autogenous/Alloplastic Materials and Their Complications." *Journal of Nutritional & Environmental Medicine* 8.3 (1998): 289-300. Web.

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