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Analysis of Minerals Using Linearly Polarized Infrared Microspectroscopy

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Analysis of minerals using the infrared microprobe is possible due to recent advances in instrumentation that removed the need for extensive sample preparation that previously minimized the application of the technique to the analysis of minerals. Since then, infrared spectral libraries of standard minerals were prepared from whole mineral grains and used for comparison with samples of unknown origin [1]. In addition, the analysis of mineral grains at specific crystal orientations was purported to be useful for the evaluation of molecular and structural properties of these samples [2].

For this study, mid-infrared attenuated total reflection (ATR) spectra of standard mineral preparations were collected with linearly polarized radiation to further evaluate the impact of crystal orientation. In addition, spectra collected from petrographic sections are compared with spectra collected from mineral standards. The infrared microprobe used to collect all polarized infrared spectra was a Smiths Detection (Danbury, CT) IlluminatIR II with wire-grid linear polarizer and diamond ATR microscope objective. Conventional polarized light microscopy and crystal morphology techniques were used to establish crystal orientation. Results show that, depending upon the mineral's crystal structure and chemical composition, polarized infrared spectra can provide additional information about a material's solid-state structure.

The polarized infrared spectra collected from three different minerals in various orientations are shown in Figures 1, 2, 3 and 4. The spectra from quartz are shown in Figures 1 and 2. In Figure 1, analysis was performed when the crystal was positioned so that the electric field vector was parallel to the c-axis for one spectrum and parallel to the a-axis for the other. In Figure 2, the electric field vector was parallel to the a-axis for all four spectra. These four spectra were collected orthogonally to each other. The spectra collected from tourmaline and calcite are shown in Figures 3 and 4, respectively. For tourmaline, the spectra were collected with the electric field vector parallel to the c-axis in two of the spectra, and parallel to the a-axis in the other two. The spectra of calcite were collected when the sample was positioned in three different orientations. For two of the spectra, the sample was positioned with the electric field vector parallel to the c-axis. The other two spectra were collected looking down on the 1 0 -1 1 crystallographic face and were, unexpectedly, reproducibly different from each other and from the spectra with the electric field vector oriented parallel the c-axis.

References

- [1] BA Weinger, JA Reffner and PR De Forest (2008). Rapid, Reliable and Reviewable Mineral Identification with Infrared Microprobe Analysis. In K Ritz, L Dawson and D Miller (Eds.), *Criminal and Environmental Soil Forensics* (pages 431-444). Netherlands: Springer.
- [2] JA Reffner, BA Weinger and PE Leary (2008). Infrared Microprobe Analysis of Minerals Using Internal Reflection Spectroscopy. *Microscopy and Microanalysis*, **14** (Suppl. 2), pp 1288-1289.

Figure 1. Quartz Spectra - Electric Field Vector Parallel to the c- and a-Axes

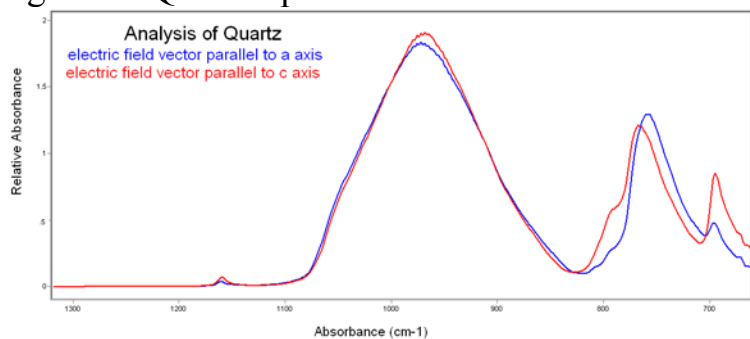


Figure 2. Quartz Spectra - Electric Field Vector Parallel to the a-Axis

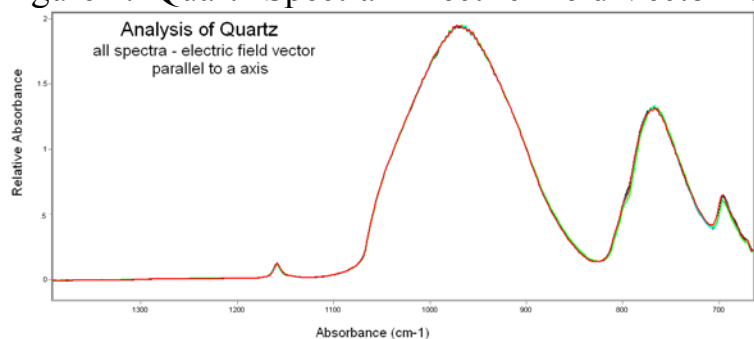


Figure 3. Tourmaline Spectra - Electric Field Vector Parallel to the c- and a-Axes

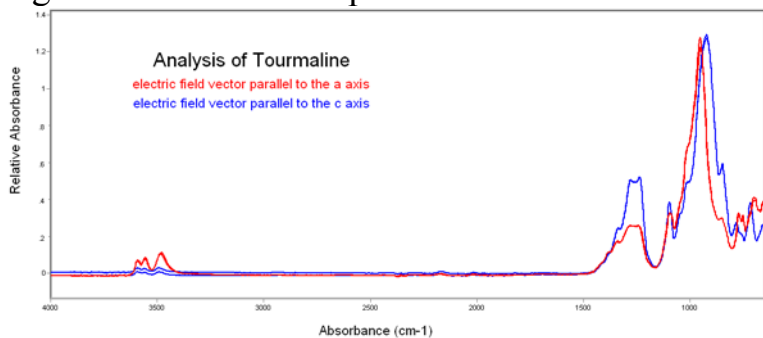


Figure 4. Calcite Spectra – Collected at Normal Incidence to a 1 0-1 1 Crystallographic Face

