A near- to far-IR data base of thin film absorption spectra of minerals

A. M. Hofmeister [1], E. T. Keppel [2], J. E. Bowey[3] & Speck, A. K.[4]

[1]*Dept. Earth and Planet. Sci., Washington University, 1 Brookings Dr., St Louis, MO 63110, USA.*
[2]*Dept. Civil Engr. and Geol. Sci., University of Notre Dame, Notre Dame, IN 46556, USA.*
[3]*Dept. of Physics, Queen Mary & Westfield College, London, E1 4NS, UK.*
[4]*Astronomy Department, University of Illinois, 1002 W. Green Street, Urbana, IL 61801 USA.*

There are unidentified bands in the ISO spectra, ostensibly of phases other than the olivines and pyroxenes studied so far. We are constructing a data base of thin film IR spectra of 80 minerals from $\sim 1\mu$m to $\sim 250\mu$m. The focus is on the far-IR for which laboratory spectra are rare even though this spectral region provides the best opportunity of phase identification due to the types of modes active there.

Problems with Previous Laboratory Spectra: The powder dispersion technique has been problematic because the thicknesses of particulates in the dispersions are larger than the thicknesses of the silicate grains ($< 0.1\mu$m) that transmit the intense peaks (Hofmeister 1995). Consequently, the spectrum from dispersions contains artifacts in position and width due to the inate dependence of absorbance on thickness and optical depth, as well as to problems with correcting a baseline for a partially opaque sample. Inferences of optical constants from those dispersions result in overly large damping coefficients (width of the peaks in real part of dielectric function) and underestimations of oscillator strength (essentially peak intensity).

Our Method: Thin films are made by compressing the powdered sample in a diamond anvil cell, which then serves as a sample holder. This method yields absorption spectra which correspond quantitatively to absorptivity calculated from Kramers-Kronig analysis of single-crystal reflectivity spectra (e.g. Chopelas and Hofmeister 1991). Hence, reliable optical and dielectric functions can be extracted from these data (e.g. Speck et al. 1999).

Minerals Included in our Study: We have assembled a collection of minerals found in primitive meteorites and those expected to occur in the condensation sequence. These include olivines, pyroxenes, Ca and Al-bearing minerals, silicas (SiO_2) and layered and hydrous silicates. Several minerals that are common in meteorites, but heretofore unidentified in spectra of astronomical objects, e.g. melilites, are included for completeness.

Detailed effects of Mg/Fe ratio are revealed in spectra of a series of olivine samples. Various pyroxenes are examined to differentiate between effects of chemistry (Mg, Fe, Ca, Al) and between the two main structures for this mineral family. Spectra of quartz (which has reflectivity data with which to compare) were gathered from different thicknesses to further our understanding the role of optical path.

The talk will discuss key examples and overall trends.

References:

Chopelas and Hofmeister, Phys. Chem. Minerals 18, 279-293, 1991
Hofmeister, A.M. 1995 p. 377-416 in *Practical guide to infrared microspectroscopy*, ed. H. J. Humiki
Speck et al. ApJL, 513, L87, 1999