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Emissivity and reflectance measurement at low and high T of different hydrous salts: a tool to study the surface of the icy planets

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Icy planets, in particular Jupiter's moons, have attracted the scientific investigation due to the likely presence of oceans under crust which may potentially support life. Recent decision of NASA to go forward with plans for new mission to Europa provides strong incentives to deep the knowledge of the surface composition trough the analysis of exiting spacecraft data and telescopic observation. Really for the present-day researchers consider the beneath the icy surface of Europa is the most promising place to look environments suitable for life

The *non-ice* Europa's materials represent a question up to know not completely solved notwithstanding its relevance in planetary science and astrobiology. Preliminary data indicate that chloride and sulphate hydrates are important as extraterrestrial salts but a good database on the spectral features of some of them is lucking. The data known usually are restricted in a small frequency range and the collection of data is a function of temperature, atmosphere composition and are well grain distribution is very lacking.

The collection of a library of possible *non-ice* spectra should be fundamental for a correct and exhaustive interpretation of the remote data.

Recently Hanley et al (2016) [1] published reflectance spectra of hydrated chlorite salts, at room and low temperature to observe the effects of temperature on diagnostic spectral features.

They showed that at low temperature increase the resolution of the spectra since the bands become narrower with sharper and better defined minima and showed distint spectra features which should be interesting to interpretate remote sensing data.

About sulphate minerals there are a more extensive library, but a systematic study of the evolution of the spectra with chemistry, temperature and atmosphere composition is lacking. Moreover the published data refer to a limited spectra range, usually under 2.5 micron, where the sulphate signature is very poor (Dalton III B., 2003) [2]

In this study the emissivity and reflectance spectra of an accurately selected group of minerals were collected at low and high temperature to investigate the role of both the chemical substitutions (cations as well anions) and the amount of water molecules on spectral features. The samples investigated were: alcaline-earth alkaline sulphate [thenardite Na_2SO_4, arcanite K_2SO_4, barite $BaSO_4$, gypsum $CaSO_4$ 2H2O], magnesium sulphates with different water contents [kieserite $MgSO_4$ (H_2O), pentahydrite $MgSO_4 \cdot 5(H_2O)$,epsomite $MgSO_4 \cdot 7(H_2O)$], chloride [halite NaCl, silvite KCl]and
mixed salts [bloedite $Na_2Mg(SO_4)_2 \cdot 4(H_2O)$,loweite $Na_{12}Mg_7(SO_4)_{13} \cdot 15(H_2O)$, kainite $MgSO_4 \cdot KCl \cdot 3(H_2O)$, carnallite $KMgCl_3 \cdot 6(H_2O)$, polyalite $K_2Ca_2Mg(SO_4)_4 \cdot 2(H_2O)$]

Four sets of measurements were collected:

a) Emissivity in a purging environment at different Temperature (T) up to 130 °C
b) Emissivity under vacuum at T between 200 and 500 °C
c) Reflectance in a vacuum environment at room T
d) Reflectance in a vacuum environment with the samples freezed at -80 °C

Refectance measurements were collected on the same set of samples, both on the fresh ones and recoiled after heating.

Emissivity measurements, in the 1-16 micron spectral range, were collected with two Bruker Vertex 80V FTIR spectrometers, a nitrogen-cooled MCT detector and a KBr beamsplitter. One spectrometer was connected to a purged emissivity chamber for T_{sample} less than 130 °C, the second was working in vacuum for T_{sample} between 180 and 500 °C.

Reflectance measurement at 20° and -80 °C (by using a sample cooling device) were collected with a Bruker Vertex 80V FTIR spectrometers. All samples were recovered after the heating and freezing cycle measurements and were characterized by a chemical and structural point of view by using electron microprobe and X-ray diffraction.

The final aim of the project is to improve the spectral library of possible *non-ice* materials and to associate the structural and chemical changes to selected bands in the emissivity and reflectance spectra. Moreover the spectral evolution studied over a wide T range, from -80 °C to around 500°C allows us understanding the T dependence gradient for different spectral bands.

These data will help to extract more detailed information from the remote data, moreover suggestions on which area and which data should have higher priority for remote investigations in the future space missions, could be derived.

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References

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