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Dehydration kinetics of hydrohalite under UV irradiation

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Abstract

We will present first results of a study characterizing the dehydration rate of fine grained hydrohalite as a function of temperature under UV irradiation. These results will help to infer the surface history of Europa by comparing remote sensing data from future Europa Clipper instruments to a systematic catalog of laboratory analogs.

1. Introduction

The investigation of ocean materials expressed on the surface of airless icy bodies, such as Europa or Enceladus, when exposed to surface temperature, vacuum, photolysis and radiolysis may bring light in the understanding of subsurface processes and corresponding timescales.

Hydrated salt minerals are one species of surface materials found by former space instruments. We selected hydrohalite as candidate material for systematic dehydration studies since it is the only stable hydration state of sodium chloride under Europa conditions compared to other materials which have numerous stable hydration states.

This work will provide the means to interpret the data acquired by future missions to icy worlds such as Europa Clipper and JUICE. Sodium chloride on Europa's surface may be directly and unambiguously identified if the characteristic spectral features of hydrohalite are observed because the spectrum of anhydrous NaCl is flat and indistinct [1] If features of hydrohalite are found they would indicate a relatively young terrain.

2. Methods

To analyze the hydration state of hydrohalite samples we use a combination of two different, but complementary techniques: 1. Passive near-infrared reflectance spectroscopy in the 1.4-7.0µm spectral range (Thermo Nicolet 6700 FTIR; Pike Tech DiffusIR) 2. Raman spectroscopy (Horiba Jobin-Yvon LabRam HR). The sample is irradiated using a krypton arc lamp primarily emitting at 116.5 and 123.6nm, however the 116.5nm line is cutoff by the MgF_2 window.

3. Sample material

Hydrohalite forms in saturated NaCl solution below 268K. To ensure reproducible samples and particle size distribution we adapted a sample production protocol developed at Technical University of Braunschweig [2] and previously used for photometric studies [3]. A PARI Vios PRO Nebulizer System for medical applications is used to spray a saturated brine directly in liquid nitrogen using a 3bar compressor. The resulting particle radii were measured as 1.47+0.96-0.58µm [3].

4. Expected results

It is expected that lower temperatures will slow down the chemical reaction rates. The NIR-spectrum of water ice is known to be very sensitive to particles size, where smaller grains show more pronounced absorption features but are more reflective on inter-bands.

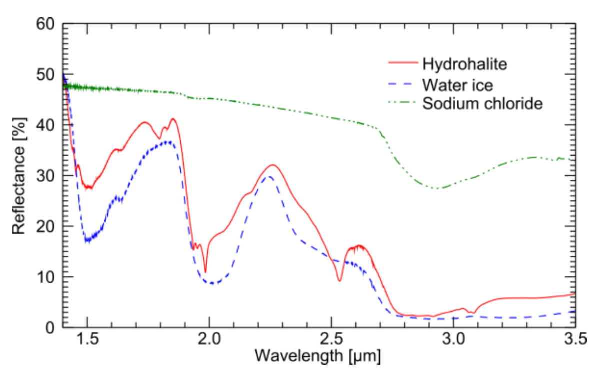

Figure 1: Preliminary NIR-spectra of hydrohalite, sodium chloride and water ice, all samples were crushed by a mortar and sieved with a 200µm mesh size.

It has to be investigated how particle-sintering at higher temperatures, where the total surface area is decreased, which should decrease reaction rates, influences the dehydration kinetics. This could potentially lead to non-linear effects.

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References

[1] Thomas, E. C., Hodyss, R., Vu, T. H., Johnson, P. V., Choukroun, M. Composition and Evolution of Frozen Chloride Brines under the Surface Conditions of Europa, Earth and Space Chemistry, 2017.

[2] Gundlach, B., Kilias, S., Beitz, E., Blum, J.: Micrometer-sized ice particles for planetary-science experiments – 1. Preparation, critical rolling friction force, and specific surface energy. Icarus 214, p. 717-723, 2011.

[3] Jost, B., Gundlach, B., Pommerol, A., Oesert, J., Gorb, S.N., Blum, J., Thomas, N.: Micrometer-sized ice particles for planetary-science experiments - II Bidirectional reflectance. Icarus 225, p. 352-366, 2013.