Spectrophotometric characterization of cometary analogs in the laboratory in support of Rosetta data interpretation

LOSSY
Laboratory for Outflow Studies of Sublimating Materials

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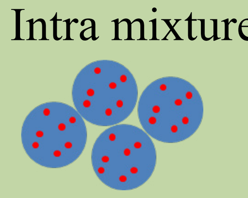
Sample material

As a cometary analog material pure water ice particles (67±31µm) are mixed with 0.2 wt.% of nanometer sized carbon black (42nm) and 0.1 wt.% of complex organics (tholins, particle size 315±185nm [3]).

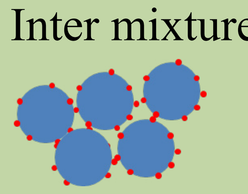
The sample preparation is done in two different ways:

1. Intra mixture

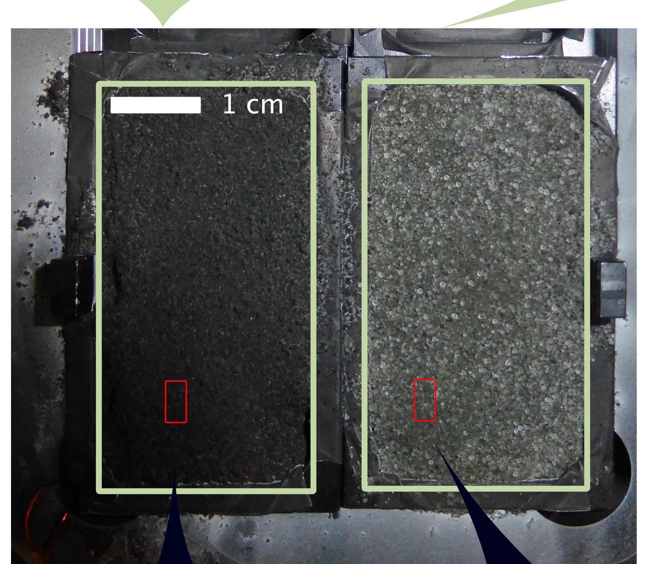


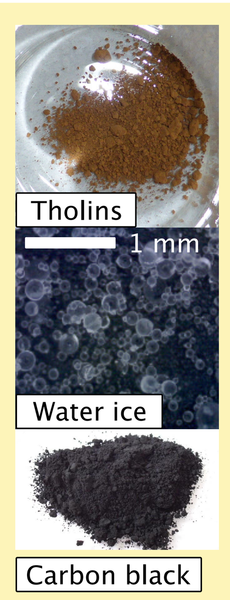
a suspension of water with carbon and organics is sprayed into liquid nitrogen

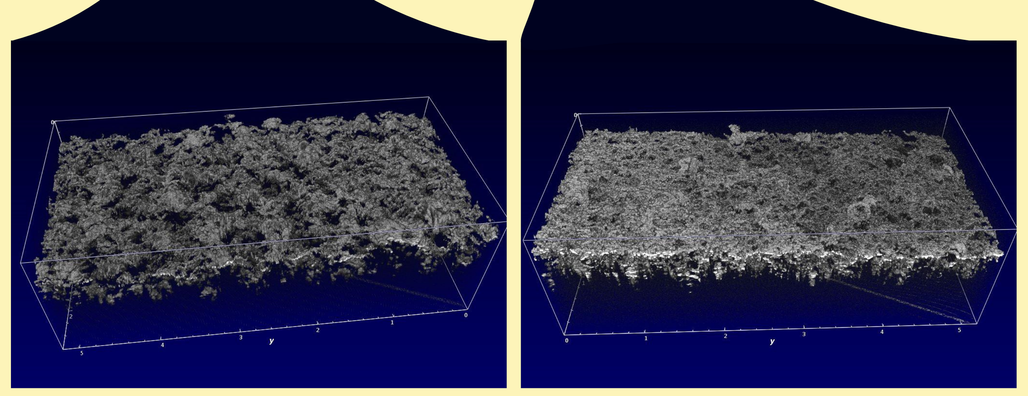
2. Inter mixture



pure water is sprayed into liquid nitrogen and afterward coated with carbon and organics in a dry phase







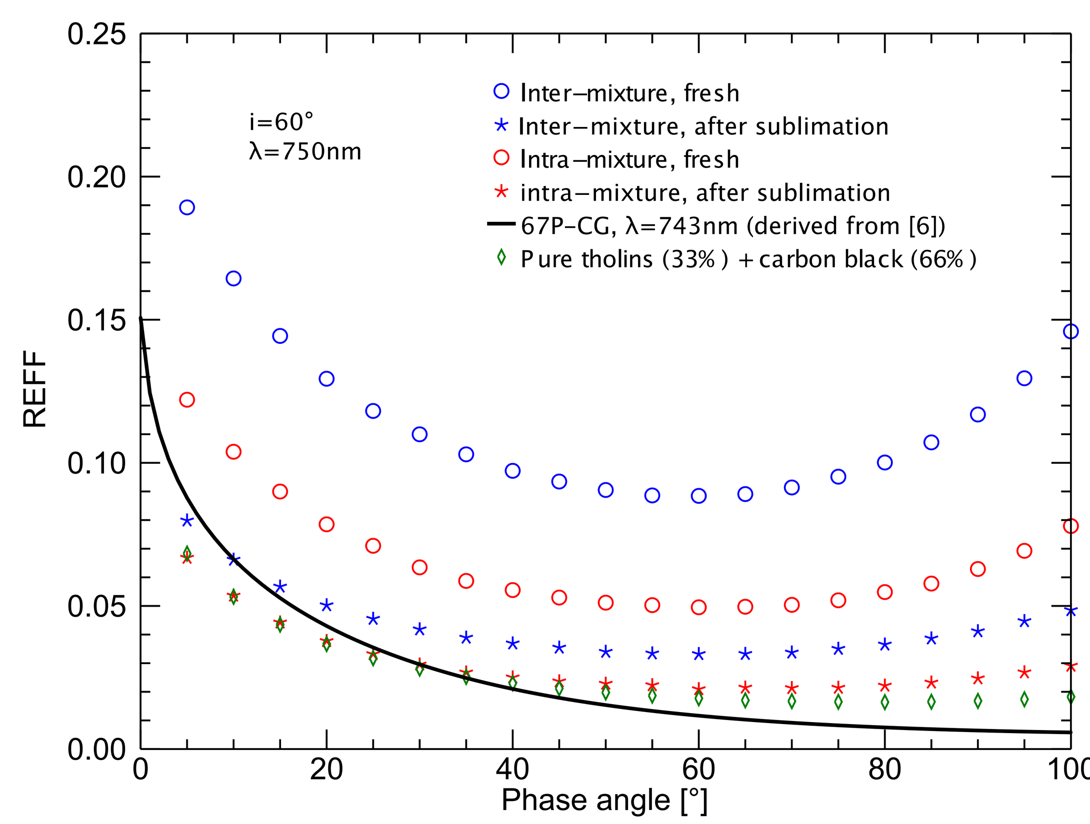
In-situ 3D surface renderings, performed with an OCT (optical coherence tomography) instrument, acquired through the chamber window

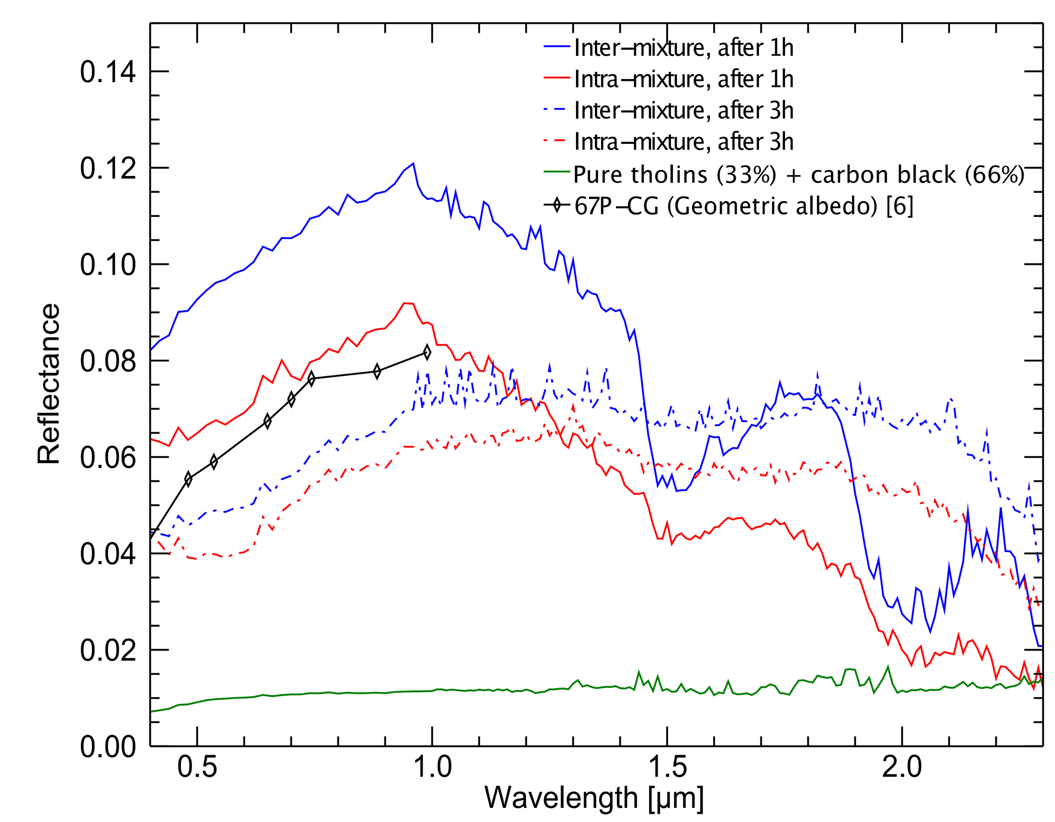
Context

The OSIRIS imaging system [1] onboard European Space Agency's Rosetta mission has been orbiting the comet 67P/Churyumov-Gerasimenko (67P) since August 2014. It provides an enormous quantity of high resolution images of the nucleus in the visible spectral range. 67P revealed an unexpected diversity of complex surface structures and spectral properties have also been measured [2].

To better interpret this data, a profound knowledge of analog surfaces is essential. For this reason we have set up the LOSSy laboratory (Laboratory of Outflow Studies of Sublimating Materials) to study the spectrophotometric properties of ice-bearing cometary nucleus analogs. The main focus lies on the characterization of the surface evolution under simulated space conditions.

Photometry results





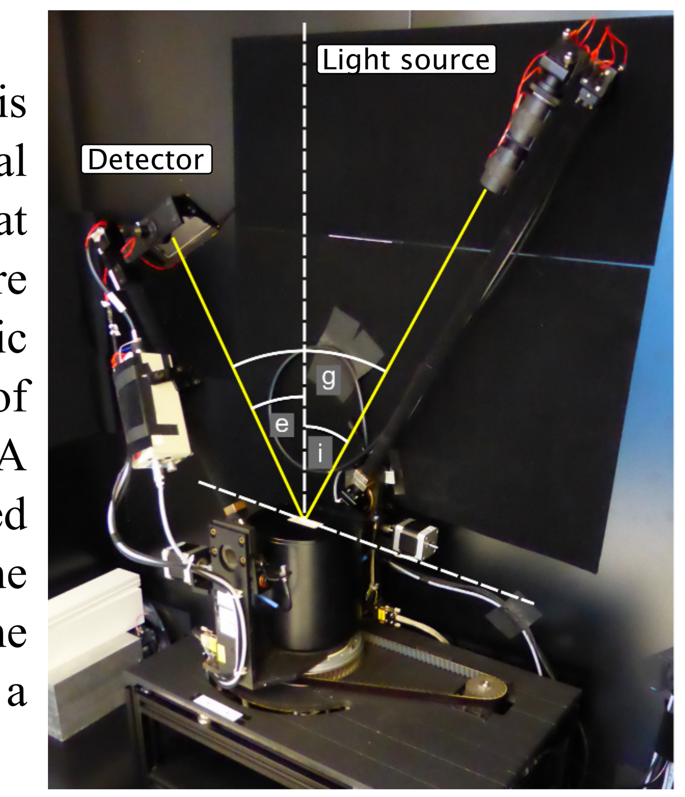
Phase curves of the two samples are acquired before and after the sublimation process. Additional to a general decrease in brightness, the partially sublimated surfaces show less scattering in the forward direction due to higher macroscopic roughness.
The sublimed surfaces have higher coincidences with the scattering properties of 67P, differences can be explained by different size scales

The VIS-NIR reflectance spectra show a red slope in the visible range for all samples. The disappearance of water absorption bands in the NIR range with time, combined with a general darkening, is due to sublimation of ice and the formation of a residue layer. The intra-mixture is systematically darker than the inter-mixture.

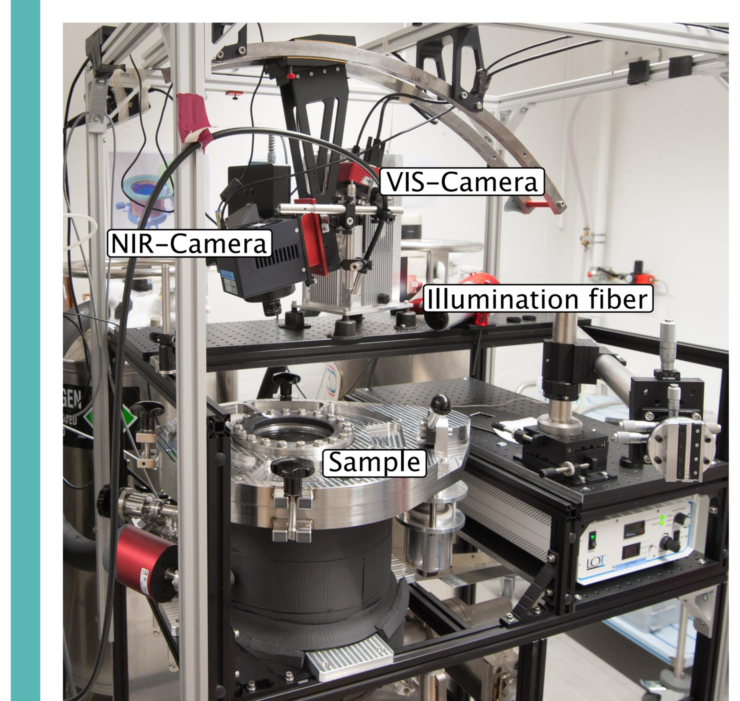
Instrumentation

PHIRE2

The PHIRE-2 gonio-radiometer [4] is designed to measure bidirectional reflectance of cm-size samples at ambient or subzero temperature (down to 238K) and atmospheric pressure over a wide range of geometries, including opposition. A collimated light source is equipped with six bandpass filters over the 450-1064nm spectral range. The scattered light is measured with a silicon photovoltaic sensor.



SCITEAS



The SCITEAS simulation chamber [5] is built for in-situ monitoring of subliming samples under low temperature (170 -200K) and low pressure (< 10^{-6} mbar) conditions using a VIS-NIR hyperspectral imaging system. To simulate illumination conditions a 1 solar constants sun simulator can be switched on.

References

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