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Spectro-photometric properties of mixtures of Titan tholins with water ice measured in the laboratory to support the interpretation of Huygens DISR spectra

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Because of its thick atmosphere containing a few percents of methane, the surface of Titan can only be observed –from Earth and from orbit– through narrow atmospheric spectral windows present in the near-infrared methane absorption spectrum. Earth-based telescopic observations, followed by closer observations by the Cassini Visual and Infrared Mapping Spectrometer (VIMS) or by the Synthetic Aperture Radar (SAR) have shown that Titan surface is composed of bright and dark areas whose reflectance values seem consistent with bright organics or dark organics mixed with variable amounts of water ice respectively. Retrieving the composition of Titan surface from these data is a difficult task, principally because of the limited amount of reflectance data available in the near-infrared.

The Huygens probe descended through the Titan's atmosphere and landed at its surface on January 2005. The Descent Imager/Spectral Radiometer (DISR) onboard the probe recorded some reflectance values at different phase angles of bright dendritic highlands and dark lowland plains where the probe ultimately landed. Continuous surface reflectance spectra from 0.48 to 1.60 μm have also been acquired from a meters to a few centimeters above the surface. These spectra exhibit a red slope from 0.48 to 0.82 μm, a featureless blue slope from 0.82 to 1.40 μm and a unique absorption band centered around 1.54 μm. While the visible red slope is probably due to tholins-like material, the near infrared blue slope and the 1.54 μm absorption band have not been accurately explained yet. Water ice has been suggested to be the source of the absorption at 1.54 μm but its presence seems inconsistent with the lack of other water absorption bands at 1.04 and 1.25 μm. Additionally, spectra measured by DISR have an overall reflectance about 3 to 4 times lower than those of Titan tholins produced in the laboratory. Finally, DISR data tentatively show a higher overall reflectance at low phase angles, indicating that the surface of the Huygens landing site may exhibit an opposition surge, suggestive of a peculiar surface texture.

More than 10 years after the landing of Huygens at the surface of Titan, the data obtained by the DISR instrument are still puzzling and no definitive interpretation has been proposed to explain the reflectance spectrum and the scattering properties of the surface. In order to contribute to the interpretation of the Huygens DISR data, we have measured the bidirectional reflectance and the complete reflectance spectra (from 0.48 to 1.60 μm) of mixtures of water ice with Titan tholins, and of some organic molecules. The measurements have been performed using the PHIRE-2 radio-goniometer and the SCITEAS simulation chamber developed at the University of Bern. We will present measurements of the absolute reflectance of mixtures of Titan tholins and water ice, including the phase curve at the opposition geometry. We will also discuss the possible origins of the 1.54 μm absorption feature, the low albedo, and the near infrared blue slope seen on the Huygens landing site.