Optical properties of analogs of Titan's aerosols produced by dusty plasma

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The atmosphere of Titan is mainly composed of nitrogen and methane. Solid aerosols are at the origin of its yellow color. They are produced by photochemistry and by the electrons from Saturn's magnetosphere.

Here we present the optical properties of Titan's aerosols analogs (tholins) produced in a dusty Radio Frequency plasma discharge: the PAMPRE experiment [1]. The solid particles are produced in the gas phase as dust or as thin films on substrates for different amount of CH_4 in N_2 up to 10%.

SEM images analyses allow to compare the morphologies of the particles and to measure the size distribution of the grains [2].

The refractive indices of tholins are measured from 370 nm to 900 nm by spectroscopic ellipsometry on the thin films deposited on Silicon substrates. The absorption decreases from near UV to near IR [3] and for a given wavelength decreases when the injected amount of CH_4 increases [4]. With mid-infrared absorption spectra analyses, the evolution of functional groups are followed that allows connecting them to the evolution of refractive indices with wavelengths and injected amount of CH_4 [5].

The color of the samples changes from clear to dark brown. Reflectance spectra on tholin surfaces have been studied using a bidirectional set-up with various geometrical observations [6].

The scattered light by lifted particles by an air-draught is studied with the PROGRA^2 instrument and its linear polarization is deduced as a function of the phase angle for two wavelengths (red and green) [7]. The size of the constituent grains, which depends on the production conditions, is a main parameter [2-7]. The grains are agglomerated and form particles in (50-100) μm size range, lifted by the nitrogen-draught. The polarization is compared to the results of the space observations. To obtain the high polarization values observed in the upper atmosphere of Titan at about 90° phase angle, a grain diameter in the 100 nm range is deduced from our measurements [2]. Such a value was also deduced from numerical simulations of the DISR/Huygens probe observations [8,9]. The spectral gradient in polarization is negative for the tholins, it is similar to the observed one by Voyager 2 from the outside of the satellite (integrated fluxes) and can be due to a higher absorption in green than in red light in the large agglomerates [10]. If the agglomerates diameter is smaller than 10 μm, the polarization spectral gradient is positive, similar to the DISR observations looking upward in the atmosphere.

References

[1] Szopa et al., PSS 54, 394 (2006)
[2] Hadamcik et al., PSS 57, 1631 (2009)
[3] Sciamma-O'Brien et al., Icarus 218, 356 (2012)
[4] Mahjoub et al., Icarus 2012 (submitted)
[5] Gautier et al., Icarus 2012 (submitted)
[6] De Bergh et al., In The solar System beond Neptune, Barucci et al. Eds, Univ. Arizona press, Tucson, pp. 483 (2008)
[7] Hadamcik et al., NATO SPSSC, pp. 137 (2011)
[8] Tomasko et al., Nature 438, 765 (2005)
[9] Tomasko et al., PSS 56, 669 (2008)
[10] West R.A., JGR 88, A118699 (1983)