Growth of organic aerosols in a N_2-CH_4 RF plasma representative of Titan's ionosphere

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Abstract

RF plasmas in N_2-CH_4 gas mixtures lead to the formation of organic aerosols in the gas phase. Here we study the formation steps of these aerosols in the plasma.

The main goal of this study is to understand the formation of similar aerosols in Titan's ionosphere. Titan is the biggest moon of Saturn. Its atmosphere is mainly composed of nitrogen (~95%) and methane (~5%). Its upper part is ionized by solar photons and energetic particles from Saturn's magnetosphere. This leads to a complex organic chemistry, with the formation of complex positive ions, heavy negative ions and organic grains **[1]**. These grains stay several years in Titan's ionosphere and they are suspected to evolve during their stay. A model presented in **[2]** proposes two processes of growth working in parallel: surface growth and grains coagulation. Here we experimentally investigate the growth of organic particles staying in a plasma mimicking Titan's ionosphere.

The ionosphere of Titan is simulated with a RF plasma reactor. A mixture of 95% nitrogen and 5% methane is introduced at low pressure (0.9 mbar) in a 30L chamber. The plasma discharge is confined in a 0.5L metallic box inside the chamber. Organic particles start forming when the discharge is ignited. We adjusted the gas flow and/or pulsed the plasma discharge to modify the residence time of the particles inside the plasma, as done in **[3]**. We prepared 5 different samples.

We first analysed the samples by Scanning Electron Microscopy (SEM). We confirmed that the longer grains stay in the plasma, the bigger they grow. Smallest grains are 140 nm in diameter while the biggest reach 5 µm. The samples formed with the longest exposure to plasma show aggregates up to 20 µm in size in which particles are tightly linked to each other (see **Figure 1**). This observation supports strongly the combined growth model proposed by **[2]**.

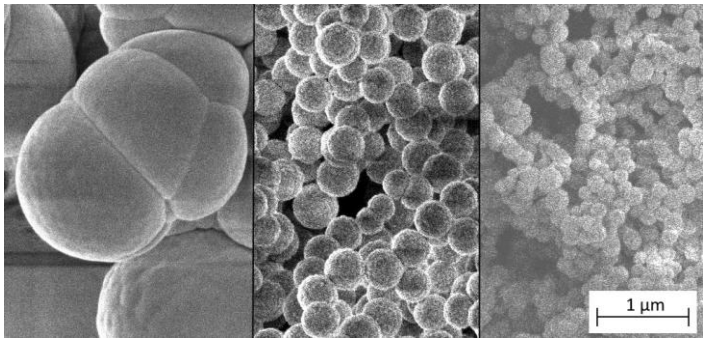

Figure 1. SEM pictures of different samples

The chemical functions of the samples can be investigated with infrared transmission spectroscopy, as done in **[4]**. Bigger grains significantly have a different IR signature than smaller grains, especially concerning the C-H and the nitrile bands. Therefore, the long exposure to plasma also alters the chemical structure of the organic grains formed.

References

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