Surface-active substances in a laboratory simulated Titan's organic haze: Prebiotic microstructures

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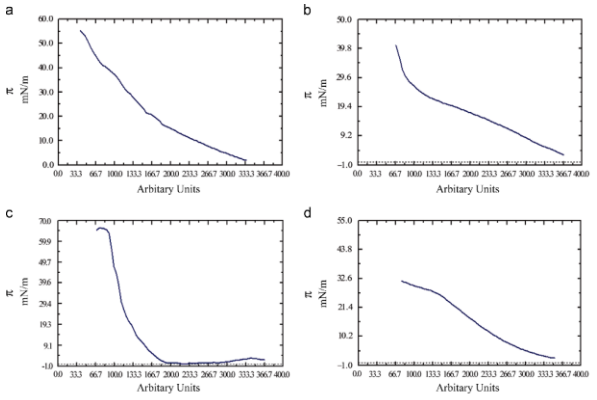
Introduction:

This work focuses on using laboratory simulations of the organic chemistry on Titan to advance our understanding of prebiotic evolution. Titan, largest satellite of Saturn can serve as a contemporary environment for investigating prebiological organic chemistry on a planetary scale, due its analogies with planet Earth, presence of active organic chemistry and liquid water ocean underneath its icy crust. Surface active substances such as amphiphiles play potential roles in the prebiotic chemistry.

Amphiphilic compounds are essential components of all life today. Certain amphiphiles can spontaneously form stable lipid bilayer membranes that define cell boundaries. Because the first cellular life did not have metabolic pathways to synthesize the phospholipids and sterols that comprise biomembranes of contemporary microorganisms, a reasonable assumption is that amphiphilic molecules were present in the prebiotic environment, either synthesized by geochemical processes or perhaps delivered by late accretionary infall. These were then used by primitive cellular life as a source of self-assembled membranes.

The primary aim was to determine whether tholin represent possible sources of surface active substances that could have been involved in the formation of prebiotic structures. A tholin sample was extracted with chloroform-methanol and the chloroform soluble material was separated by two dimensional thin layer chromatography. Fluorescence excited by UV light was used to identify the major components on the plates. After beings scraped from the TLC palte, the components were eluted s specific fraction and investigated by surface chemical methods, FTIR, scanning electron microscopy and cyclic voltammetry. Fractions 1 and 2 were strongly fluorescent and surface active, producing films at air-water interfaces. When exposed to aqueous phases, components in fraction 1 form spherical microstructures resembling prebionts. The prebionts are precursors structures that might evolved into the first living cells



Surface pressure-area isotherms of (a) Fraction 1, (b) Fraction 2, (c) Stearyl amine and (d) Stearyl nitrile monolayer at RT on a water subphase

References: Allara D.L and Nuzzo R.G. (1985) Langmuir, 1, 45-52.
Blodgett K.B. (1934) J.Am.Chem.Soc. 56, 495.
Deamer D.W. (1989) Nature 317, 792-794.