Reactivity of Laboratory Titan Tholins with Ice under Laser-Simulated Meteoritic Impact

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On Titan, tholins are formed in the upper atmosphere by the interaction of UV light, energetic electrons from Saturn's magnetosphere and cosmic rays with the main atmospheric constituents N_2 and CH_4 [1, 2]. Tholins accumulate over geologic time in substantial amounts on Titan surface, mainly composed of water ice, ponds and lakes of cold liquid hydrocarbons (ethane, propane). Titan's thick atmosphere protects the surface from ultraviolet radiation, however tholins and other condensed atmospheric organics may be processed on Titan surface by high energy cosmic rays reaching the surface [3] and meteoritic bombardment [4]. Products relevant to life [5] such as amino acids [6], carboxylic acids, purines and pyrimidines [4] could be formed on Titan's surface when impact events exposed sediments of ices and Titan tholins, transiently, to aqueous conditions [4], leading to the hydrolysis of tholins [6]. Here we report the laboratory study of the interaction of Titan tholins with icy surfaces exposed to impact shocks.

A Nd-YAG pulsed laser has been used to simulate the energetic processes during meteoritic impacts [7]. The experiments have consisted in ablating pure water ice with Titan tholins deposited above the ice at 77 K. The chemical changes and reactivity of impacted tholins as well as the formation of complex organic compounds in the impacted ice have been examined with analytical techniques such as FTIR diffuse reflectance spectroscopy of tholins and GC-MS for the identification of amino acids, hydroxy acids, carboxylic acids and nucleobases in the ablated ice.

Keywords: Titan tholin; meteorite impact; icy surface; laboratory experiment.

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