FIBER OPTIC PROBES FOR IN SITU DETERMINATION OF TITAN LAKE HABITABILITY. M. L. Cable[1], T. H. Vu[1], M. J. Malaska[1] and R. Hodyss[1], [1]NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109 (Morgan.L.Cable@jpl.nasa.gov).

Introduction: The lakes of Titan serve as a medium for the complex chemical interchanges between the surface and the atmosphere. The lakes are a repository for the products of atmospheric chemistry, connecting Titan's geology, atmosphere, and astrobiological potential. Erosion, pluvial transport of organics, and partitioning of photochemical products between atmosphere and liquid will all leave traces in the chemical composition of the lakes. This plethora of organic molecules (acrylonitrile, HCN, etc.) in a methane/ethane cryogenic soup might form the building blocks for a new type of life. A detailed understanding of lake composition and stratification is therefore a primary goal of any future Titan mission.

Standard organic analysis techniques such as mass spectrometry require acquisition and transfer of a sample to the instrument. This is problematic considering the surface temperature of Titan (94 K). Volatilization, exsolvation and fractionation during sample handling are all major obstacles to overcome. Spectroscopic methods provide an alternative when coupled with fiber optics, enabling in situ analysis of lake samples *without alteration*. Fiber optic probes could be used in the lakes to: (1) quantify the ratio of major hydrocarbon components, (2) measure the abundance of trace species, and (3) determine depth profiles, important in assessing habitability of this environment.

To these aims, we are developing three fiber optic probe-based instruments to perform in situ chemical characterization of Titan's lakes. Two of these instruments take advantage of commercially available miniature spectrometers and sources to significantly reduce mass and volume. Such instruments could be included on a future Titan lake lander or submersible.

The three fiber-coupled instruments cover different spectral regions. Mid-IR (2.0-9.0 µm) and NIR/SWIR (0.9-2.5 µm) absorption spectrometers determine lake composition by measuring the proportions of methane, ethane and propane. Absorption in the UV/Vis (190-650 nm) region is used to identify and quantify trace species, such as benzene and naphthalene. Here we report results of testing these instruments in various hydrocarbon solutions at Titan-relevant temperatures.

Methods: All three instruments were assembled using commercial components and multimode optical fibers appropriate for the target wavelength range. Miniature spectrometers (Ocean Optics) were used for the UV/Vis and NIR/SWIR instruments. Aliquots of methane, ethane and/or propane were condensed in a custom-built cryostat under N_2 atmosphere at 93 K [1,2]. Hydrocarbon volumes were measured using a plastic pipette cooled in LN_2. For UV/Vis measurements, benzene and naphthalene were dissolved to saturation (18.5 and 0.16 mg/L, respectively) in liquid ethane at 95 K [3]. Solutions were allowed to equilibrate 1 hr prior to collection of spectra.

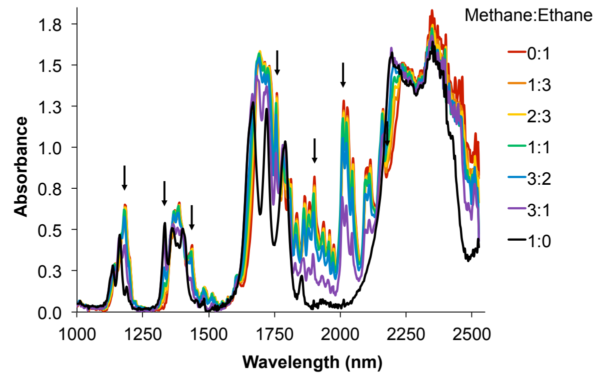

Figure 1. Absorbance spectra of methane/ethane mixtures at 93 K collected by the NIR/SWIR prototype instrument. Key features that change with hydrocarbon ratio are identified with arrows.

Results: Different ratios of methane, ethane and propane were easily distinguished with characteristic absorption features in both the mid-IR and NIR/SWIR (Fig. 1). Benzene and naphthalene were both identified in the UV/Vis absorption spectrum of the saturated ethane solution, consistent with previous work in our lab with a different light source and probe [4].

Conclusions: Three fiber optic probe-based instruments were successfully demonstrated at Titan relevant temperatures for three different wavelength regimes. Two of these instruments were based on miniature spectrometers and have small footprints, making them ideal for a future in situ Titan lake mission.

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