

An Ocean World in a Laboratory

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Introduction: Ocean Worlds are planetary bodies, which contain a substantial amount of water, in the form of surface or sub-surface oceans. Within our Solar System, Jupiter's moons Europa, Ganymede, and Callisto; Saturn's moons Titan and Enceladus; Neptune's moon Triton and Pluto have been identified as potential Ocean Worlds [1]. The conditions on these Ocean Worlds vary greatly, including extreme environments. In the search for biosignatures, one needs to take these conditions into consideration. For example, the surfaces of Europa and Enceladus are continuously bombarded by high energy radiation [2,3,4]. Laboratory facilities are needed to mimic these environments. This presentation details the design and development of a new facility, ICEE (In-situ Carbon Evolution Experiments), for just such studies.

ICEE Facility: The NASA Ames ICEE Facility is a state-of-the-art facility, comprised of three stations; an Ultra-High vacuum (UHV) chamber, a Raman microscope, and a dust grain surface station.

ICEE UHV chamber: The ultra-high vacuum (UHV) chamber (10^{-9} torr) contains a cryo-cooler and multiple radiation sources, capable of replicating a wide variety of Solar System conditions. These include a high energy electron gun, flowing H_2 discharge lamp and a soft X-ray source (Figure 1). An IR transparent window is mounted onto the tip of a rotatable Helium cryo-cooler, which is capable of temperatures between 15 and 300 K. A gas inlet and organic deposition port permits deposition of samples under a variety of conditions. Samples can be analyzed in-situ with a variety of analytical techniques.

Raman microscope: The Raman microscope is equipped with an auto microscope stage, permitting rapid survey scans of sample materials. The microscope is equipped with x5, x20, x50 and x100 objective lenses which can be utilized in the analysis of Ocean World Analog materials [4,5].

FIRE Station (Fourier transform Infrared and Raman Experiments): The facility also has a stand-alone FTIR spectrometer. This spectrometer can be utilized with a Harrick Praying Mantis DRIFTS (Diffuse Reflectance Infrared Fourier Transform Spectroscopy) equipped with a low temperature chamber (-150 °C to 600 °C) capable of pressures from high vacuum to 133

kPa (1ktorr). The low temperature chamber has been modified to utilize a flowing H_2 discharge lamp for photolysis experiments and can mimic grain surface chemistry on Ocean Worlds. The iS50 FTIR spectrometer can also be utilized with an iS50 FTRaman module that can measure the Raman spectra of a wide variety of samples utilizing a 1064 nm laser.

This presentation will detail the design of this new facility as well as present some of the latest experimental results.

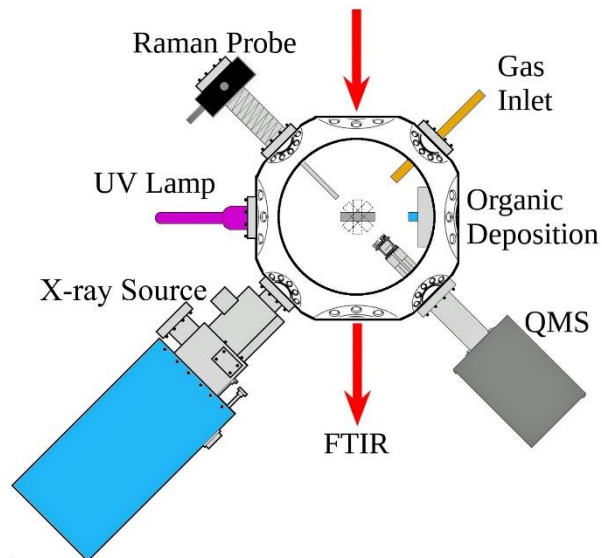


Figure 1. Overview of the ICEE chamber, showing the radiation sources as well as the in-situ characterization techniques.

References:

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