

INFRARED SPECTRA OF C₂H₆ AND C₂H₆-H₂O. A. S. Curry², R. M. Mastrapa¹, J. A. Myszka³, ¹NASA Ames Research Center, SETI Institute; ²Cal Poly Pomona; ³Villanova University.

Introduction: Ethane has thought to be seen in the clouds of Titan [1] and the surface of TNOs [2]. The method for identifying this compound is through infrared spectroscopy. Spectra of ethane have been taken in laboratories, but only at limited temperatures, and with limited mixtures. Previous results have demonstrated that the absorptions of mixtures are different in shape and location than the pure substances [3, 4]. To be more certain that ethane does exist in these places, we need a more complete set of data. This project attempts to provide spectra of ethane, as well as ethane water mixtures at a more complete range of temperatures relevant to the Solar System. Spectra were taken in both the nir range (1-3.5 μ m) and the mid infrared range (2.5-20 μ m).

Methods: To achieve these goals, we used a gas sample of pure ethane and a separate gas sample of a water-ethane mixture at a 20:1 ratio. The system we used to collect our data consists of many different components. We used a diffusion pump backed by a mechanical pump to bring the vacuum to its lowest pressure of 10⁻⁸ torr. A helium refrigerator is used to cool the system down to its lowest temperature of 15 K. When depositing a sample, we cool the system to the desired temperature. The gas is deposited onto a window in the form of an ice. Using a laser and photometer we use interference fringes to determine the thickness of the sample.

C₂H₆: Ethane deposits were done at a low temperature (15K), and a high temperature (50K). Spectra were taken at these temperatures immediately upon deposit. For both high and low temperature deposits, samples were heated at 1 K per minute. For low temperature deposits, we took spectra at 20K, and at every 10K up to 60K. We then cooled back down to 15 K. In one experiment we heated to 75 K, where the spectra show that pure ethane sublimates. The purpose of this heating and cooling was to see if we could observe any phase changes or temperature dependent changes. If a phase change occurs, a new absorption may appear in the spectra and remain regardless of temperature changes. A temperature dependent change in the spectra will fluctuate depending on the temperature of the sample.

C₂H₆-H₂O: The water ethane mixture was consistently deposited at 50 K. Samples were heated at 2 K per minute to 100 K, 150K/160K, and then cooled to 15 K. The water was deposited in the amorphous phase and was heated to 150/160 K to crystallize the sample. The sample was heated again to 40 K, 60 K, 80 K, 120 K and 160 K at 2 K per minute. This allowed phase or

temperature dependent changes to be seen in more detail.

Results: We will be focusing on shifts in the centers of the bands, as well as qualitative changes in the shape of the bands. This includes shoulders and splitting of the absorptions. Ethane has distinct bands at 2.27 μ m, 2.32 μ m, 2.40 μ m, and 2.46 μ m. These are easily identified in Figure 1. The weaker bands at 2.29 μ m, 2.35 μ m and 2.43 μ m are found in most of the ethane spectra, but depending on phase may be more difficult to identify. The band at 2.46 μ m is split, almost into two bands. The bands at both 2.40 μ m and 2.32 μ m have distinct shoulders. However, the band at 2.32 μ m has a small peak on its base at 2.325 μ m.

Unlike pure ethane, the water ethane mixture varied greatly with temperature. The band at 2.27 μ m is one peak at 160 K, but clearly splits into two at 15K. The band at 2.29 μ m looks similar to the pure ethane spectrum, but at 160 K, this band is no longer visible. The band that is near 2.40 μ m in pure ethane shifts closer to 2.39 μ m. It is wider than in pure ethane, and at 160 K the shape is completely different – there is no longer a shoulder, and the intensity has decreased. The 2.42 μ m band looks very similar to pure ethane, and remains fairly constant even with variation in temperature. Among the ethane water spectra, the 2.46 μ m band varies mostly by way of area; the center does not shift dramatically. However, when compared to pure ethane, the band is completely different. In ethane water it is one cohesive band, while pure ethane has it split into two.

Conclusions: We have demonstrated that mixtures of water and ethane results in ice samples whose spectra differ from the pure spectra of ethane. When creating model spectra for materials in the Solar System, the type of mixing can effect the location and shape of the absorptions. These differences can also be used to interpret the physical state of the materials on surfaces in the outer Solar System. Ethane is significantly more volatile than water, but may remain trapped in water for a significant amount of time. In this way, the mixing state of these materials can be used to determine the history of the surface.

References:

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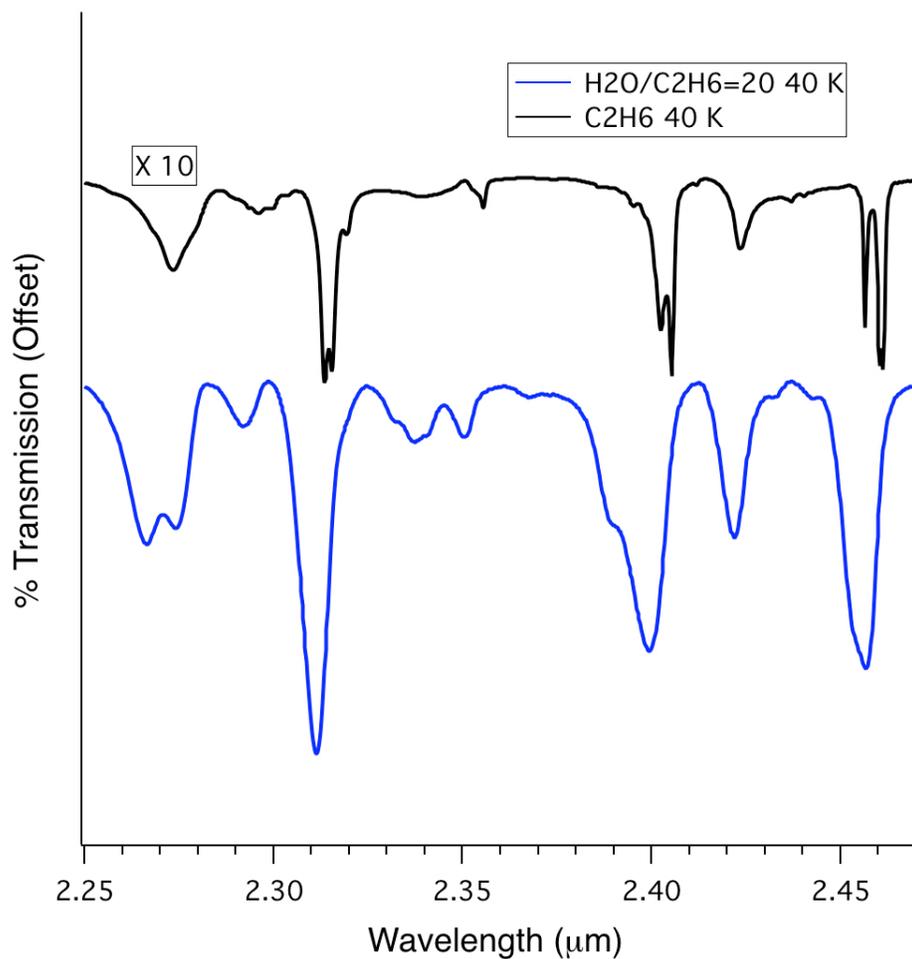


Figure 1. Spectra of pure C₂H₆ and H₂O/C₂H₆ = 20. The region near 2.3 μm usually increases as a function of wavelength, but the H₂O absorptions have been removed so that the absorptions can be compared easily. The C₂H₆ spectrum was multiplied by 10 to increase the strength of the bands. Both spectra were offset from each other for clarity.