Vapor Pressures and Heats of Vaporization of Some Organic Acid Ices. Paul. D. Cooper[1,2], Marla. H. Moore[2] and Reggie. L. Hudson[3], [1]Department of Chemistry and Biochemistry, MS 3E2, George Mason University, Fairfax, VA 22030-4444 (pcooper@gmu.edu), [2]NASA Goddard Space Flight Center, Astrochemistry Branch, Code 691, Greenbelt, MD 20771 (Marla.H.Moore@nasa.gov), [3]Department of Chemistry, Eckerd College, 4200 54th Avenue South, St Petersburg, FL 33711 (hudsonrl@eckerd.edu)

Introduction: Identifying frozen acids on solar system surfaces has been more difficult than identifying solid H_2O, H_2O_2, O_2, or O_3. It has been known for some time that there is a close match between sulfuric acid hydrates and the near-IR spectrum of Europa [1]

Carbonic acid (H_2CO_3) is another molecule of interest, being the dominant product when $H_2O + CO_2$ ice mixtures are either irradiated or photolyzed [2-4], The temperature range over which $H_2O + CO_2$ can be processed to form H_2CO_3 has not been investigated, and essentially nothing on the vapor pressure of this acid has been published. That such information is needed is demonstrated by a suggested match of weak 3.88-μm features on Ganymede and Callisto with H_2CO_3 [5]. The spectra, formation, and stability of H_2CO_3 at different temperatures also have implications for its likely presence and detection on surfaces from Mars to beyond Pluto.

Of similar interest is formic acid (HCOOH) and acetic acid (CH_3COOH). While both species have been detected in the ISM, formic acid has also been observed in cometary comae. Both species may also be formed on icy satellite surfaces – formic acid is known to be produced in irradiated H_2O + CO ices and acetic acid is likely produced in $CH_4 + CO_2$ ices.

The formation and thermal evolution of these acids is important in understanding the surface chemistry of icy satellites.

Results: We will present data on a series of laboratory experiments designed to measure the vapor pressures of the three organic acids listed above, as well as heats of vaporization for each acid. These experiments utilize infrared spectroscopy of thin-film ice samples to measure these properties.

We have used the transmission of infrared light by a thin ice film deposited onto a cooled optical window to measure absorption spectra of formic and acetic acid at different temperatures. We observed the rate of loss of the ice, *R*, defined as the number of molecules leaving the unit area in unit time, and using the Knudsen equation (1), where *m* is the molecular mass of the species, *T* is the temperature, and *k* is the Boltzmann constant, the vapor pressure *p*, was calculated.

$$R = \frac{p}{\sqrt{2\pi mkT}} \qquad (1)$$

From the vapor pressures obtained at different temperatures, the Clausius-Clapeyron (2) equation was used to determine the heat of vaporization.

$$\ln\left(\frac{p_2}{p_1}\right) = -\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \qquad (2)$$

Carbonic acid was synthesized on a polished aluminum mirror from an irradiated mixture of H_2O + CO_2. The absorption spectrum was measured using the reflectance method. We will provide data to show whether or not carbonic acid is thermally stable and sublimes into the gas phase (and has a measurable vapor pressure), or whether it undergoes thermal decomposition to H_2O and CO_2.

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