UNDERSTANDING THE EFFECT OF ETHYLENE GLYCOL ON COMETARY WATER. W Khan[1], R Ramachandran[1], P Sundararajan[1], J K Meka[1], B N Rajasekhar[2], S Ganesh[1], A Bhardwaj[1], N J Mason[3], B Sivaraman[1], [1] Physical Research Laboratory, Ahmedabad, India (ragav.kasak@gmail.com, bhala@prl.res.in), [2] Bhabha Atomic Research Center, Mumbai, India, [3] University of Kent, Kent, UK.

Introduction: In general comets are enriched with water (H_2O), followed by CO_2, CO etc [1]. A lot of organic molecules have been detected in ISM, Ethylene glycol [$(CH_2OH)_2$] is one of those molecules which is present in comets. Ethylene glycol (EG) was first detected in comet C/1995 O1 (Hale-Bopp)[2] and later in other comets like C/2012 F6 (Lemmon), C/2013 R1 (Lovejoy)[3], C/2014 Q2 (Lovejoy)[4] and 67P/Curyumov-Gerasimenko [5]. In terrestrial conditions, EG is used as an antifreeze to prevent liquid H_2O from turning into ice. The temperature dependent IR spectral studies on the effect of EG on H_2O ice in cometary and other astrochemical icy conditions are limited [6]. In this work, we present the temperature dependent IR study of EG and H_2O mixed ice deposited at such extreme conditions. Since the OH peaks of H_2O and EG overlap, it becomes very challenging to understand the effect of EG on H_2O using IR spectroscopy. To overcome this challenge, we use D_2O instead of H_2O. It is also worthy to note that the deuterated water is also present in comets with deuterium-to-hydrogen ratio (D/H) values of the order of 10^{-4} [7][8].

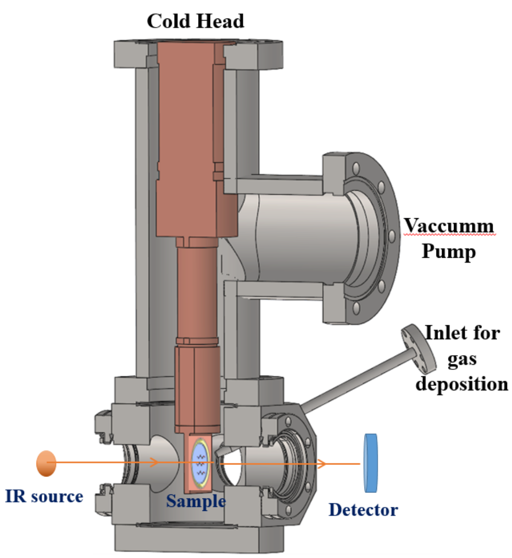

Fig. 1: Schematic of the SALT chamber used to carry out the experiments.

Methodology: Ethylene Glycol (>99% purity, Merck) and D_2O (>99% purity, Fisher scientific), available as liquid, were used. The experiments have been carried out under low temperature (7-300 K) and pressure (~10^{-10} mBar) conditions using the SALT (Simulator for Astro-molecules at Low Temperature) setup housed at the Physical Research Laboratory, India (A schematic of the experimental chamber is given in Fig. 1). Mixtures of EG and D_2O were deposited at 7 K for 20 minutes and warmed to higher temperatures at a constant rate 5 K min^{-1}. The ice was probed in-situ by FTIR spectroscopy using Thermo Scientific Nicolet iS-10 FTIR Spectrometer while the temperature was controlled using the Lakeshore 335. Similar procedure was followed for pure EG and pure D_2O experiments.

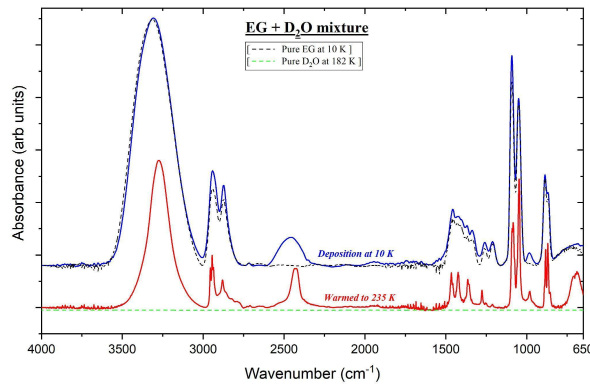

Fig. 2: IR spectra of EG-D_2O mixture at 10 K *(blue)* and 235 K *(red)*, pure EG spectra at 10 K *(dashed black)* and pure D_2O at 182 K *(dashed green)*.

Results and Discussion: Selected IR spectra of a series of experiments are given in Fig. 2. We observe a strong interaction between EG and D_2O even in such extreme conditions. From the present experiments, we see that even though complete sublimation temperature of pure D_2O occurs at 182 K, the EG and D_2O mixture doesn't sublimate even at 235 K. In fact, the complete sublimation of the mixture occurs at ~245 K. So from these experiments we have compelling evidence that H_2O/D_2O can be found on comets, containing EG, even at higher temperatures than previously known.

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