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The new RAIRS system at the THz/Far-IR Beamline - Laboratory Astrochemistry.

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The second half of 2016 has seen the completion of a bespoke experiment installed at the THz/Far-IR Beamline. Funded by the ARC through CI Ennis' DECRA project, the apparatus has been designed for dual-purpose Matrix-Isolation and Reflection-Absorption Infrared Spectroscopy studies. A chamber sitting within the beamline's Bruker FTIR sample compartment reaches high-vacuum by differential pumping. This chamber supports the second-stage of a compressed helium cryocooler where the mounted sample surfaces (either IR transmission windows or polished metal substrates for reflection studies) can be cooled to 10 K. Low temperature chemical vapour deposition methods are used to deposit thin films of molecular ices where their morphologies can be controlled by annealing the solid. Alternatively, inert matrices of noble gases containing reactive radicals and intermediates could be produced by electric discharge or photolysis of the deposition gas stream. 270 degree rotation of the coldhead allows for sequential 'sample deposition/spectrum acquisition' for temporal film growth studies, as well as allowing for transmission and grazing angle measurements to be performed on the same instrument.

Initial experiments will interrogate the physical and optical properties of thin nitrile films. Small nitrile molecules, such as hydrogen cyanide, acetonitrile, and propionitrile have all been identified in their condensed phase within the cold atmosphere of Saturn's largest moon Titan. The product of ongoing photochemical and fast particle processing of nitrogen and methane in the ionosphere, nitrile species transport to lower altitudes. Here, they can condense as icy layers on the surfaces of haze particles, where the layer morphology is specific to the physical conditions present at the atmospheric location. The condensed-phase also act as sites where higher-order chemistry can unfold more efficiently than the gas – such as complex cyanide chemistry pathways thought to lead to amino-acid synthesis in cold, extra-terrestrial environments.

This talk will introduce our first forays into laboratory astrochemistry at the Australian Synchrotron; connecting previous aerosol experiments to our current thin-film work on nitrile ice morphology. Also highlighted will be new DFT methods (using computationally lenient code Crystal14) that have returned accurate vibrational frequencies, particularly for intermolecular translation and libration modes associated with the far-IR for molecular crystals. Finally, the capabilities of the new RAIRS system will be detailed to promote its use amongst the infrared beamline community as an additional accessory for low temperature analysis of the condensed-phases.

Keywords or phrases (comma separated)

Infrared, Condensed-phase, Molecular ices, Instrument development, Astrochemistry

Are you a student?

No

Do you wish to take part in</br>the Student Poster Slam?

No

Are you an ECR? (<5 yrs</br>since PhD/Masters)

No

What is your gender?

Male

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