OREOcube: ORganics Exposure in Orbit. R. Quinn[1], A. Elsaesser[2], P. Ehrenfreund[2], A. Ricco[3], A. Breitenbach[4] J. Chan[4], A. Fresneau[2], J. Alonzo[5], A. Mattioda[3], F. Salama[3], O. Santos[3], Ella Sciamma-O'Brien[3], H. Cottin[6], E. Dartois[7], L. d'Hendecourt[7], R. Demets[8], B. Foing[8], Z. Martins[9], M. Sephton[9], M. Spaans[10], [1]Carl Sagan Center, SETI Institute, Mountain View, CA USA, (email: Richard.C.Quinn@nasa.gov), [2]Leiden Institute of Chemistry, Leiden University, NL, [3]NASA Ames Research Center, Moffett Field, CA USA, [4]San Jose State University, CA USA, [5]California State Polytechnic University, Pomona, CA USA, [6]LISA, Universite Paris Est Creteil, FR, [7]IAS, Orsay, FR, [8]ESTEC, Noordwijk, NL, [9]Imperial College London, UK, [10]University of Groningen, NL

Introduction: The ORganics Exposure in Orbit (OREOcube) experiment is designed to measure chemical changes in organic samples in contact with inorganic substrates to investigate the role solid mineral surfaces may play in the (photo)chemical evolution and distribution of organics in the interstellar medium, comets, meteorites, and other bodies. Currently under development in preparation for a 12-month deployment on an International Space Station (ISS) external platform, OREOcube uses UV/visible/near-IR spectroscopy for *in situ* sample measurement. Based on technology developed by NASA Ames Research Center's Small Spacecraft Payloads and Technologies Team, OREOcube is comprised of two 10-cm cubes each containing a highly capable spectrometer for the monitoring of samples held in a 24-sample cell carrier. Each cube is an autonomous a stand-alone instrument package, requiring only a standard power-and-data interface, with integrated electronics, a microcontroller, data storage, and optics to enable the use of the Sun for photochemical studies (124 to 2600 nm) and as a light source for spectroscopy (Fig. 1).

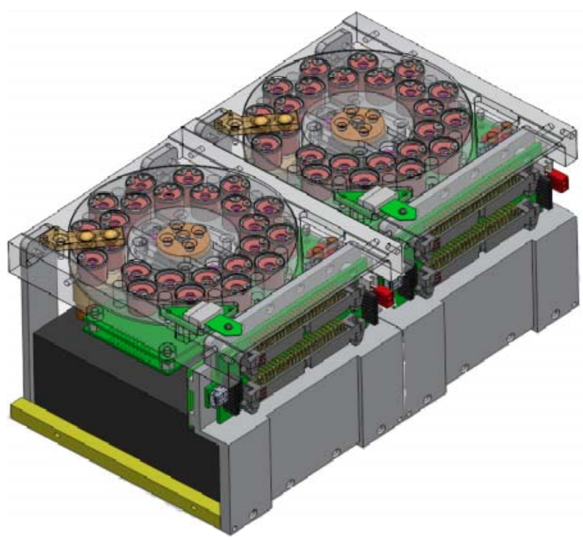

Fig. 1. OREOcube payload. Two independent 10-cm cubes each containing a 24-sample cell carrier and an integrated UV/Vis/NIR spectrometer are used to measure changes in in organic compounds exposed to low-Earth-orbit radiation conditions on an ISS external platform.

The OREOcube experiment: In an OREOcube experiment, an adsorbate-substrate interface is defined by depositing organic samples as thin films onto solid substrates. This provides a controlled method to examine organic samples and inorganic surface interactions. Surfaces provide multiple mechanistic pathways that can drive chemical transformations of organic molecules exposed to radiation. Depending on the substrate, both physi- and chemisorption can result in new photochemical processes in both the adsorbate and the surface. A large number of different adsorbate-substrate photochemical processes can occur, including the creation of new excitation or de-excitation pathways, photoinduced polymerization, bimolecular surface reactions initiated by dissociation of an adsorbed species, electron hole capture by the adsorbed molecule resulting from photon absorption by the substrate and the formation of substrate electron–hole pairs, and photocatalysis. Samples are housed in hermetically sealed reaction cells containing an internal test environment that allows control of headspace gases including the partial pressure of water vapor (Fig. 2). The

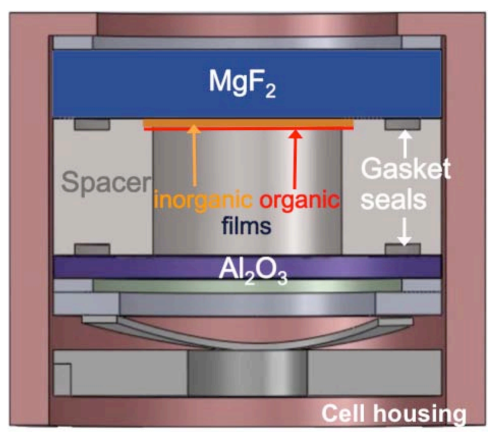

Fig. 2. OREOcube reaction cells. Inorganic and organic thin-film samples are deposited on optical windows and hermetically sealed in sample cells containing controlled headspace gas(es). Samples are exposed to direct sunlight, on an external ISS platform, through the top of the cell. The Sun is also used as a light source for spectroscopy (measured via collection optics positioned at the bottom of the cell linked to the spectrometer).

sealed sample cell also allows for the study of chemical processes related to planetary atmospheres.

Figure 3 shows a spectrum of an OREOcube tryptophan sample deposited on hematite. Also shown, for reference, are spectra of the individual thin-film components (i.e., tryptophan and hematite). By using thin-film samples, changes in UV/Vis/NIR absorption bands can be measured as a function of time. By measuring chemical changes *in situ*, OREOcube will provide data sets that capture critical kinetic and mechanistic details of sample reactions that are not obtainable with the current exposure facilities on the ISS.

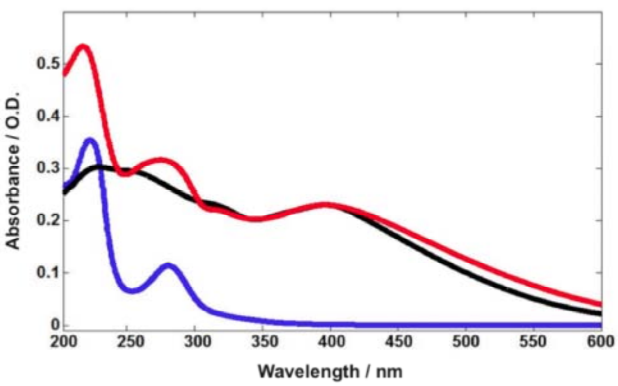

Fig. 3. Spectrum of an OREOcube tryptophan sample deposited on hematite (red). For comparison, tryptophan (blue) and hematite (black) spectra are also shown.

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