AMINO ACID SURVIVAL UNDER AMBIENT MARTIAN SURFACE UV LIGHTING. J. R. C. Garry[1] and I. L. ten Kate[2], R. Ruiterkamp[1,2], Z. Peeters[1], B. Lehmann[3], B.H. Foing[3], P.Ehrenfreund[4]; [1]Leiden Institute of Chemistry, Leiden University, [2]Leiden Observatory, Leiden University, [3]ESTEC, ESA, Noordwijk, [4]Institute 'Anton Pannekoek', Amsterdam, the Netherlands.

Introduction: We seek to characterize and understand the response of organic molecules to the conditions found near the surface of Mars. The presence and longevity of meteoritic organic matter in the martian environment places constraints on the resources available to form or sustain a putative martian biosphere.

Experiments have been conducted in which thin layers of glycine have been irradiated with a UV lamp that gives a good match to the insolation spectrum at Mars' surface. Transmission spectroscopy of the amino acid before and after irradiation provides vital data to establish a degradation rate for this material.

Sample formation: Thin 25mm diameter discs of polished silicon form the substrates for the amino acid samples. These discs can be held in a dedicated vacuum chamber in such a way that they are suspended over a small oven. Powdered glycine is then added to the oven, which can be heated resistively. When the chamber is evacuated to low pressures (~ 10 mPa) the glycine sublimates from the hot oven, condensing onto one face of the discs. A pair of laser reflection interferometers provides real-time feedback about the thickness of the material that condenses onto the silicon.

Microscopy of the glycine layers was conducted with high power optical, electron (SEM), and atomic force microscopy (AFM). The thickness of the layers over the whole disc is uniform to within 5%, and the films display consistent microcrystalline forms at the nanometre scale. Figure 1 shows a typical pair of discs before and after the amino acid layer had been deposited. The two traces on the right-hand side of fig. 1 show the history of the interferometer traces – the near synchronous variation in the reflected spot intensities shows that the layer forms uniformly over a given disc.

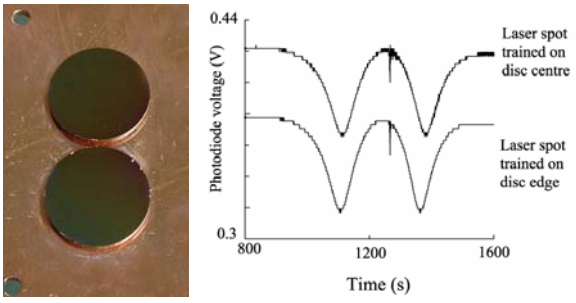

Fig.1- Silicon discs before and after deposition,and interferometry traces taken during deposition.

Fig.2- The vacuum chamber and its support equipment. The UV lamps are internal to the chamber [1].

Irradiation: Calibration of the UV lighting system in the simulation chamber shown above was performed with a NIST-traceable digital UV meter. With this meter, the spectrum provided by the UV lamps' manufacturer (Heraeus GmbH) could be transformed to give spectral intensity in absolute units, as shown below. Fig. 3 shows the light as delivered by lamps at a distance of ~0.2m from the sample discs. A model of the martian equatorial surface insolation is also shown in fig. 3. A close correspondence can be seen for the most energetic wavelengths (>200 nm) that reach the martian surface.

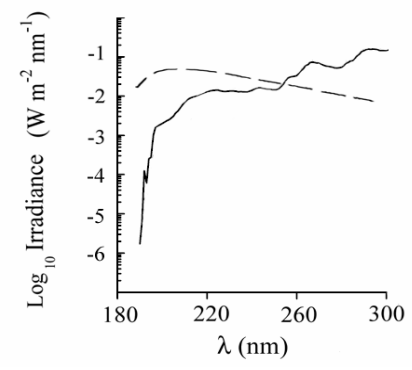

Fig.3- The spectrum of the light used to irradiate the glycine samples (dashed line), compared to a modeled mean martian equatorial surface flux [2] (solid line).

All irradiation processes were carried out under conditions of low pressure (~10 mPa) and at room temperature. A pair of discs identical to those being irradiated was kept inside the vacuum chamber, and acted as control samples. Irradiation durations of 5, 20, and 80 minutes were used, and the preliminary nature of these investigations is acknowledged – finer time divisions in future experiments will be performed.

Sample analysis: Each glycine-coated disc was examined with a transmission infra-red (IR) spectrometer. This system (Excalibur FTS-4000, BioRad, with 4 cm^{-1} resolution) was used to quantitatively measure the effect of UV irradiation on the amino acid layer. Spectra were taken of the discs before exposure to UV, and afterwards. Four spectral features associated with glycine were examined. For a given spectral marker, the integrated area of that feature was calculated prior to and following exposure to UV, and the ratio 'after' / 'before' was noted. If no material is lost from the disc as a result of UV irradiation, one would expect this ratio to be unity. Lower values would suggest degradation or removal of the glycine from the substrates – and both hypotheses will be tested in future experiments with the aid of a cold-trap equipped GCMS coupled to the chamber.

Additional measurements at shorter time scales should permit the distinction to be made between exponentially-scaling phenomena (photolytic destruction) and chemically-related diffusion-like processes.

Glycine, the simplest amino acid, is known to be readily degraded under interplanetary conditions when not shielded [3] by obscuring material. Using the set-up described earlier we will present the degradation rates of this amino acid purely as a result of UV processing, and elucidate the behaviour of this material under Mars-like conditions. Comparison with the destruction rates measured earlier [3], will provide useful insight into the alteration of meteoritic organic matter.

References: [1] Ten Kate, et al. (2002) *Int Journal of Astrobiology* **1**, 387 – 399. [2] Patel M.R., *et al* (2002) *Planet Space Sci.* **50**, 915-927. [3] Peeters Z. et al. *ApJ* (2003), **593** (2), L129-L132.

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