CRUSTAL EVOLUTION AND DUST EMISSION OF ARTIFICIAL COMETARY NUCLEI

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Recent experiments of the KOSI-Project (1-4) yielded an improved understanding of crust formation and dust emission of comet nucleus analogues under artificial solar irradiation. The development of a loose dust mantle overlaying a crust consisting of a solidified but porous ice/dust mixture was observed in all experiments so far. The importance of this layering is discussed with respect to the dust emission behaviour of the samples investigated. The dust emission itself is studied using a variety of diagnostic devices. Active and passive dust collectors allow to establish the particle flux vs. time as well as the total mass of emitted dust residuals. Especially angle, velocity, and size frequency distributions of the 3-dimensional particle flux are recorded via the spatial dust deposition on an array of 284 dust collectors. A cross check of the particle emission activity is possible via a system of 8 highly sensitive piezo impact detectors. A straight forward determination of angular distribution and velocity of the emitted particles is achieved by using high shutter speed video cameras. Records on video tape are also used to monitor the simulation experiments optically.

The dust emission activity of a given sample shows high values at the beginning of the experiment (virgin material under ~1 solar constant irradiation) and steadily decreases with increasing experiment duration (building-up of a shielding ice free dust mantle at the uppermost surface). A target body [KOSI 2] consisting of 90% water ice, 9% olivine, 1% montmorillonite and 0.083% carbon (weight percentages, dust grain sizes ~4μm) showed mass ejection rates higher by factors of >80 when illuminated for the first time compared with the aged sample in later experimental stages.

The angular distribution of emitted dust residuals turned out to be velocity and size dependent: Large low-speed particles are preferably ejected along the surface normal of the model "comet", small high-speed grains show a flat emission maximum towards the light source. The highest observed velocity of a particle >100μm is 5.2ms^{-1}. The highest mass flux occurs in the speed range of 1.4-1.7ms^{-1}. A sample [KOSI 3] containing two ice components (79.2 wt% H_2O, 12 wt% CO_2) showed particle emission with velocities comparable to CO_2 free samples. Visual inspection and video records of the surface indicate that individual particle acceleration is mainly due to a steady outflow of gas superimposed by short term (0.1 ... ≥ 1s) fluctuations of the gas stream. The resulting gas drag is increasingly quenched by the growing dust mantle, causing a gradual shift of the grain size distribution of emitted particles towards smaller sizes (cf. fig. 1).

Relaxation of internal mechanical stress in the sample leads to a spectrum of micro-seismic events which were recorded by means of an ultrasensitive accelerometer "listening" into the sample body within a frequency window of 0.2-1 MHz. Seismic events are time-correlated with the emission of groups of particles when larger surface areas of several 10 cm^2 become active at the same time. Particle emission occurs with a time lag of several seconds with respect to the precursory seismic activity in the sample.

The analysis of dynamic particle parameters (velocity, acceleration, occurrence of particle showers or micro-dust jets) is presently being extended towards smaller grain sizes in the range of $\leq 10\mu m$. This will be done by applying a specially designed He-Ne-laser counter based on acousto-optic devices.

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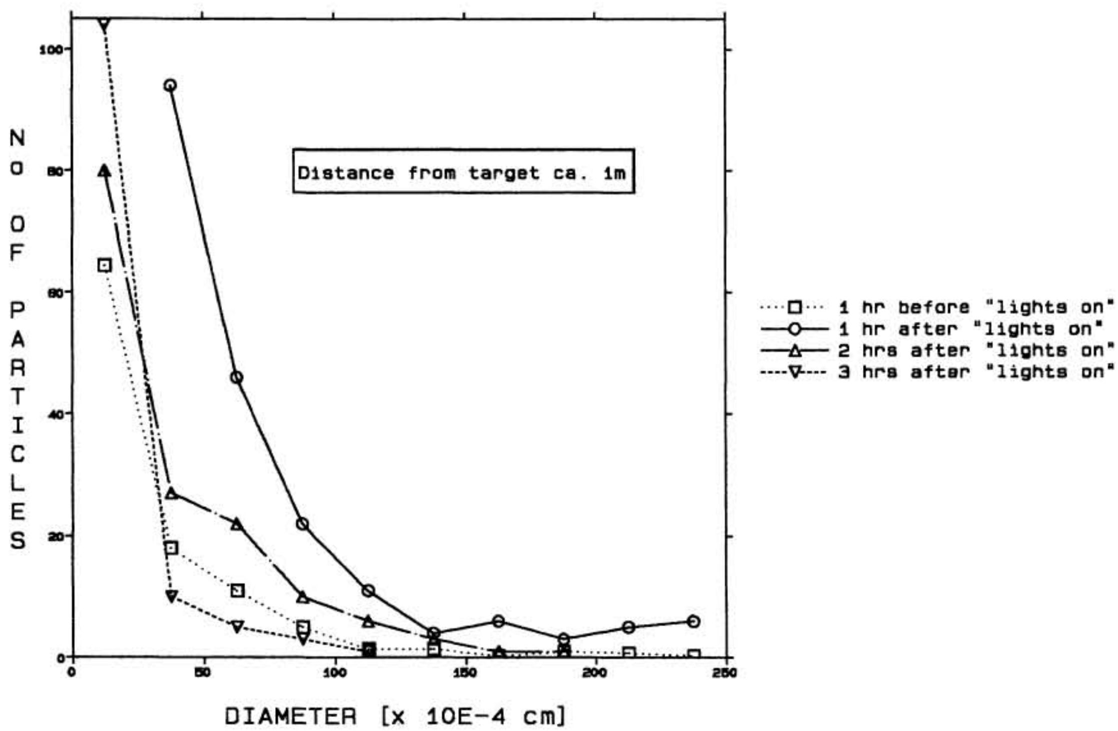

Fig. 1: Particle flux given as [particles/hr/collector area A] as a function of particle diameter ($A = 7cm^2$)

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