CHARACTERISTIC IMPACT FLASHES BY ICY METEOROIDS INFERRED FROM LABORATORY EXPERIMENTS.

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Introduction: Observations of optical flashes are one of the basic tools to study high-velocity impact phenomena in laboratory experiments [e.g. 1]. Figure 1 shows an impact flash lightcurve obtained in our laboratory experiment. The second main pulse, peaked at about 3 μs after the impact, is typical and occurs in other experiments. It would be radiated from high-temperature vapour cloud. The initial short pulse with the duration less than 1 μs appeared in the experiment where both projectile and target are made of nylon66, but does not necessarily appear in other experiments.

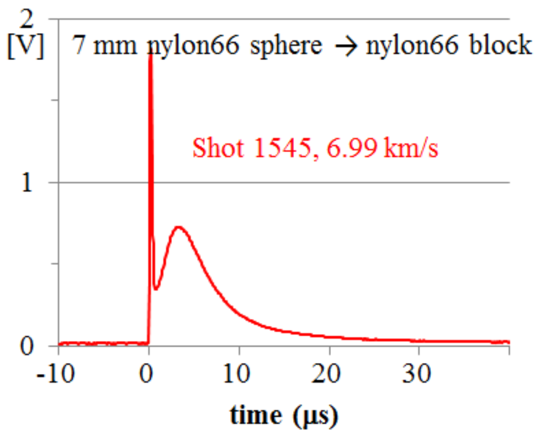

Figure 1. The time variation of an impact flash obtained in our laboratory experiment. A nylon66 sphere of 7 mm in diameter hits the flat surface of a nylon66 block normally at 6.99 km/s. The scale in the ordinate is the output voltage of a photodiode amplifier and is proportional to the light intensity in the visible wavelengths.

Experiments and Results: We conducted experiments to investigate the mechanism of the initial short pulses at the Two Stage Light Gas Gun facility in the Institute of Space and Astronautical Sciences / JAXA. Nylon spheres hit nylon blocks at 7 km/s in a vacuum condition of about 10 Pa. Impact flashes were measured by a Si photodiode (HAMAMATSU S3071) which was placed just outside the vacuum chamber and sensitive at wavelengths of about 400 – 1000 nm. An ultra-high-speed camera (ULTRA Neo, nac Image Technology) was triggered by the photodiode signal and captured an image in every 50 ns (total 12 frames). The photodiode signal is shown in Fig. 1 and three of the 12 frames in the same shot were shown in Fig. 2.

The image (a) in Fig. 2 was captured during the initial short pulse, at about 0.1 μm after the maximum flash intensity. It shows that the radiation mainly comes from the penetrating projectile. The radiation from the shock compressed high temperature region, which locates below the target surface, must be emitted through the translucent nylon projectile. The image (b) was captured near the end of the pulse. The radiation through the projectile still seems to be more intense than that from the jet or vapour cloud around the projectile.

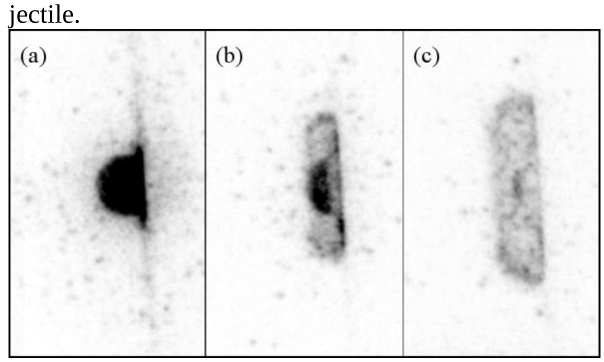

Figure 2. Three of the 12 frames obtained in the same shot as shown in Fig. 1 by a ultra-high-speed camera. Their greyscales were reversed. They were captured 0.3 (a), 0.5 (b), and 0.7 μs (c) after the contact of the projectile with the target surface. Their exposure time was 50 ns. A projectile moved from the left to the right horizontally. The target surface is seen edge-on.

Implications: The initial pulse in the lightcurve would not be observed if projectiles are opaque. It would be observed only if the optical thickness (or diameter) of the projectiles are small enough. We could hardly expect the optically thin meteoroids in the inner solar system. In the outer solar system, however, there may be many translucent or transparent icy meteoroids. In future when the observations of impact flashes on the outer belt asteroids or satellites of the giant planets become possible as the Lunar Impact Flashes [2, 3]. The existence or non-existence of the initial pulse could be used to discriminate icy meteoroids from rocky meteoroids.

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References: [1] Eichhorn G. (1976) *Planet. Space Sci., 24,* 771-781. [2] Yanagisawa M. and Kisaichi N. (2002) *Icarus, 159,* 31-38. [3] Suggs R. M. et al. (2008) *Earth Moon Planet, 102,* 293-298.