An attempt on time-domain analysis of the gases ejected by two supersonic pulsed valves into a conical nozzle

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Synopsis A new fast pulsed supersonic valve (PSV) system was developed for the Martian atmospheric simulation experiments. Two PSVs are installed in single cone and controlled individually so that formation of hyperthermal beam with mixture of two gases is fully controlled. We expect the restriction of the decomposition of CO_2 while it is accelerated by the laser-detonation phenomena. The results of beam diagnostics will be reported.

The upper Martian atmosphere is composed mainly of atomic oxygen (AO) and carbon dioxide. Martian orbiters encounter simultaneous collisions of AO and CO_2. Orbital velocity of Martian orbiters is approximately 4 km/s which is lower than that of Earth. However, >8 km/s collision occurs in the beginning of the aerobraking phase. CO_2 is chemically inactive, however collision energy of CO_2 becomes high due to its large mass. Recently, it was reported that the effect of simultaneous collision of large mass molecules in AO erosion is significant [1]. The same effect may be activated in Martian atmosphere. Therefore, effect of simultaneous collisions of AO and CO_2 over the collision velocity of >8 km/s needs to be studied.

In this study, a pulsed supersonic valve (PSV) system was developed for the Martian atmospheric simulation experiments. We developed a fast piezoelectric-driven PSV system. Figure 1 shows the photograph of the PSV system. It consists of conventional low-voltage piezoelectric actuator (Max 150V) with a displacement enlargement mechanism. Viton O-ring and Au reflector were specially designed for laser-detonation applications [2]. Most characteristic feature of this system is that two PSVs could be attached to a single nozzle (Fig.2). Two PSVs are controlled individually so that freedom of formation of hyperthermal beam with mixture of two types of gases is large. It is expected decomposition of CO_2 is inhibited in the laser plasma. Preventing of the N_2 decomposition also is required for sub-low Earth orbit (LEO) simulation. The composition and velocity of the ejected gases were analyzed by time-of-flight spectra measured by a quadrupole mass spectrometer. The experimental results will be presented and discussed.

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Fig. 1 Piezoelectric-driven supersonic pulsed valve with a displacement enlargement mechanism

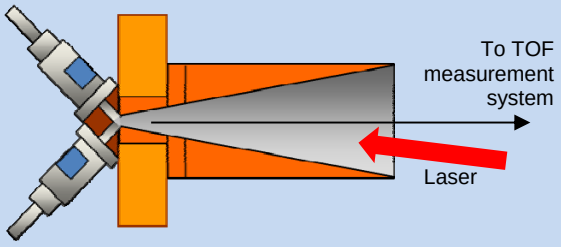

Fig. 2 Schematic drawing of the conical nozzle system with two PSVs.

References

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