Microwave emissions due to hypervelocity impact on a structure were discovered by the persons in
charge of this research. In this research, we investigate the characteristics and clarify the mechanism of the
phenomenon in order to apply to detect the impact on space structures.

The experimental system is shown in Fig. 1. It consists of an accelerator, receivers, a recorder, a
projectile and a target. It is difficult to detect the microwave emissions due to the impact because its
emission appears in a very short time as shown in Fig. 2. This is probably the reason other institutes could
not detect the emission. In this research, the microwaves in low frequency bands are recorded directly, and
those in high frequency bands are converted to an intermediate frequency band and recorded as shown in
Fig. 3.

As a result of this research, the following conclusions were obtained:

1. In the impact with a velocity of 6.7 km/sec on an aluminum plate with a thickness of 27 mm, the
maximum levels of the received signal were -67 dBm at 22 GHz, -51 dBm at 2 GHz, -40 dBm at 300MHz
and -80 dBm at 1 MHz, respectively.

2. In the impact with velocities of 2, 4 and 6.7 km/sec, the strength of the received power of the radio
wave increased as the velocity increased, as is expected. The emitted energy of the radio wave seems to be
proportional to the projectile velocity with the powers of 4.4 at 22 GHz, 6.2 at 2 GHz and 2.6 at 1MHz,
respectively.

3. The time relations between dynamics of a high temperature gas and the radio wave emission were
clarified with a time resolution of 5 µsec through the simultaneous measurement of the light emission by
using a high-speed camera. The radio wave emission seems to have a time delay of 1 to 30 µsec to the light emission.

(4) The noises which do not have a uniform spectrum were excluded by installing a filter in 300 MHz band. As a result, it was confirmed that the signal in the band appears at almost the same as that in 22 GHz band.

(5) Experiments with the targets of several materials of Al, Fe, Ag, stainless steel, brick, ceramic, etc., were carried out. It was confirmed that the strength of the radio wave emissions had correlation with the physical constants (thermal conductivity, tensile strength, etc.) of the materials in some cases.

(6) The plasma temperature was measured simultaneously and was shown to increase to 170,000 K. According to the result, it is expected that the radio wave emission with a power of -17 dBW is received in 22 GHz band. The actual received power was -45 dBW.

(7) The plasma frequency calculated from the plasma measurement is in the microwave band from 5 to 20 GHz, which is near to the measurement frequency band of 2 and 22 GHz where strong signals were observed. It is, therefore, conceivable that the emission is due to the plasma oscillations.

The microwave emission in the phenomenon is considerably strong: the estimated value of the received power in 22 GHz band with a bandwidth of 1 GHz is -45 dBm. Impacts of space debris are quite dangerous for space structures such as a space station. Refuges of crew, isolations of each block in the structure and emergency steps will be carried out when the impact occurred. Therefore, the method of regular monitoring of the impacts is required. It is considered that the phenomenon can be applied to the detection system for the space structures (Fig.4).

9. Publication List


