Experimental Study on Impact Heating of Highly Porous Bodies

Masahiko Arakawa and Kana Murazawa
Graduate School of Environmental Studies, Nagoya University

Recent planetary explorations reveled that there are a lot of impact craters on the surface of small bodies like comets and asteroids, moreover it was found that some of them had a large porosity more than 50 %. The kinetic energy of the small body colliding on the porous body could be converted to the thermal energy efficiently. The temperature observed after the impact is defined as the post shock temperature, which can heat the region around the crater for a while. Therefore, this impact heating generated on the porous body is very important for the heat source of these porous bodies.

The shock compression experiments of the porous sample were conducted by using one-stage gas gun at the impact velocity up to 400 m/s. The porous silica projectile and the ice projectile were used to impact on the porous silica target. The target was aggregate of 0.5micron amorphous silica particle and was disk with the diameter of 30 mm and the thickness of 3 to 10 mm, and the porosity was changed from 40 to 80 %. The post shock temperature was observed by an infrared video camera with the time resolution of 1/60 s.

We succeeded to measure the post shock temperature just after the impact. The maximum temperature observed in this experiment was more than 30K. The radiation temperature of the compressed sample showed the maximum at the moment of impact. Then, the temperature gradually decreased with time by thermal conduction to the sample holder. The post shock temperature (T) has a power law relationship to the impact velocity of the projectile (v_i). The relationship is described to be T=p v_i ^{q}. The coefficient q is almost a constant of 1, but the coefficient p varies with the sample porosity. According to the empirical equation obtained by this experiment, we suppose that the ices of volatile elements such as CO and N_2 could be evaporated by the collision of porous bodies at the impact velocity of 700 m/s irrespective of the porosity.