Measurements of post shock temperatures in the process of crater formation on ice

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Planetary exploration reveled that there were a lot of craters on the icy satellite. The observed crater morphology found on icy crust is different from that observed on the lunar surface made of rocks. The depth of the crater on the icy crust is usually shallower than that on the lunar surface. This is because the crater was filled with ice flowed by the stress originated from the satellite gravity. However, the surface temperature of the icy satellites is enough low for ice to be rigid at present. Therefore, it should be necessary that the crust were heated by some heat sources. The impact heating is one of the possible mechanisms to heat the crust. Thus, we made impact experiments on ice to form craters and measured the post shock temperature in order to consider the effect of the impact heating on the crater relaxation found on icy crust.

Impact experiments were conducted by using one-stage light gas gun set in a cold room at ILTS, Hokkaido Univ. The ice projectile with the mass of 1.6g was launched at the velocity from 130 to 430 m/s on the ice block with the size of 25x25x10cm. The impact crater was formed by the normal impact and the craterig process was observed by the infrared video camera to measure the post shock temperature. The video camera recorded the images with the size of 320x240 pixel every 1/60s and the temperature resolution was 0.1K.

The crater diameter (D) increased with the increase of the impact velocity (v_i) and the relationship was written by the following equation, D=a $v_i^{0.8}$. The crater morphology was changed with the impact velocity systematically. A part of the ice projectile stuck on the surface at the impact velocity from 130 to 250 m/s. The shallow circular depression excavated by the tensional stress was found around the stuck projectile. At the impact velocity higher than 250 m/s, the central pit was observed instead of the central peak of the stuck projectile. The central pit was surrounded by the shallow circular depression called as a spall region caused by the strong tensile wave reflected on the surface. We have succeeded to observe the temperature increase at the impact point after the collision. By comparing with the recovered target, we notice that the temperature increase was very confined near the impact point: the stuck projectile. We define the post shock temperature as the maximum temperature measured during the observation. The post shock temperature increases with the impact velocity from 130 to 250 m/s; the temperature changed from 2 to 4K. But, the post shock temperature for the collision of 430 m/s was below 1 K. Because at 430 m/s, the crater morphology was a pit type crater, that means the heated fragments were ejected away from the crater interior. Therefore, we could not observe the post shock temperature higher than that at 250 K.