Impact Cratering Experiments in micro-gravity environments

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Since impact cratering phenomena on planetary bodies were the key process which modified surface topology and formed regolith layer, many experimental studies were performed to elucidate the phenomena and presented some scaling laws (e.g, Mizutani et al., 1984, Holsapple 1993). However, experiments to study surface gravity effects were not many due to technical difficulties. Especially experiments in reduced gravity environments were rare, though systematic experiments in enhanced gravity environments were performed by The Boeing group using a centrifuge machine (e.g., Housen and Holsapple, 2003). Only data available to the scaling law are data in Fig. 1 of Gault and Wedekind (1977).

Recently, we performed impact cratering experiments in micro-gravity environment using the Microgravity Drop Experiment Facility of MGLAB, Toki, Japan. The facility has a vacuum tower with height of 100 m. The gravity in a capsule falling in the tower is less than 1/100,000 G. The duration of microgravity environment is 4.5 sec.

A vacuum chamber with inner diameter of 55 cm and height of 70 cm was set in the free fall capsule. Single-stage powder guns mounted in the chamber fired nylon spherical projectiles with diameter 2 to 7 mm and mass of 5 to 220 mg at velocities between 100 and 350 m/sec. Sabot and sabot stopper mechanism were employed to prevent the propellant gases from perturbing ejecta. Glass beads (Fuji FGB #200 and FGB #80) in 18 cm diameter by 15 cm depth pan were used as target. The median sizes of glass beads particle are about 0.08 and 0.2 mm. Since the capsule deceleration destroys the formed craters, all impacts were recorded by video cameras. Crater diameters were measured from video records.

Figure 1 shows the dependence of crater diameter on projectile kinetic energy. The present results indicate that there is no gravity effect on the crater diameter. This is inconsistent with results by Gault and Wedekind (1977). Their results clearly showed that the crater diameter is proportional to the G-0.165th power. The cause of this discrepancy is not clear. Further experiments in wider experimental conditions are necessary.

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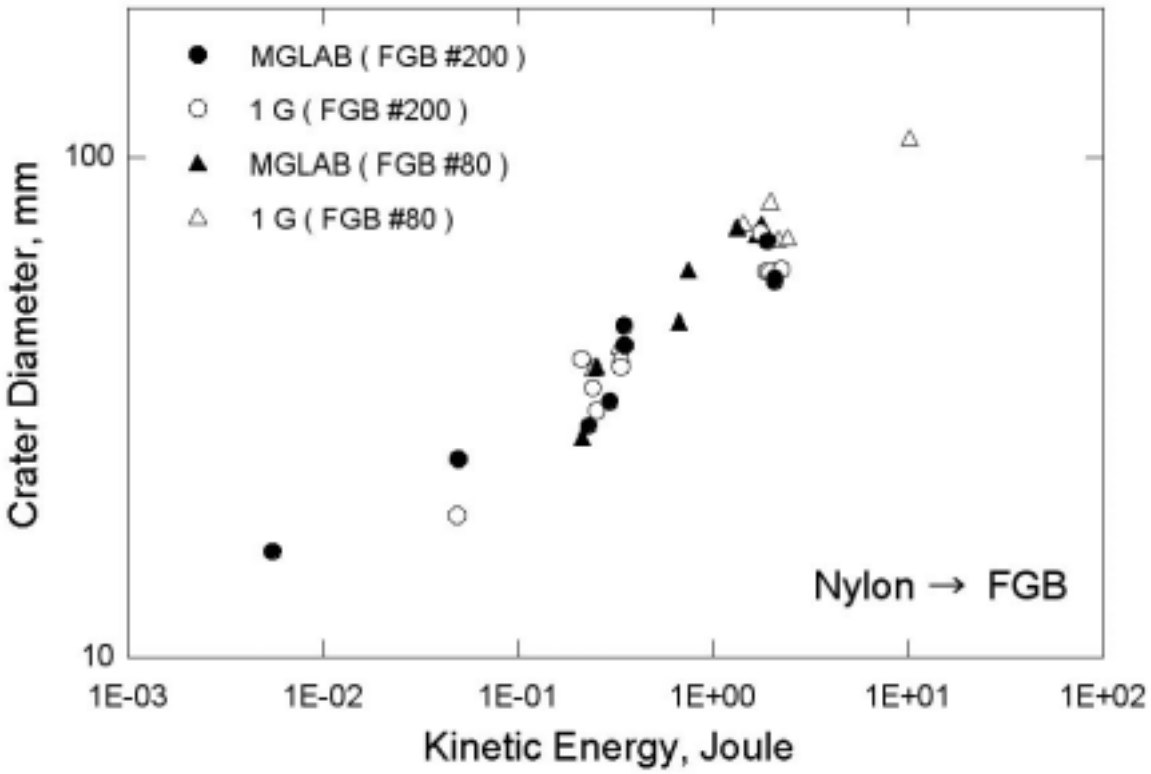
MGLAB (FGB #200)
1 G (FGB #200)
MGLAB (FGB #80)
1 G (FGB #80)
Nylon → FGB
Crater Diameter, mm
100
10
1E-03
1E-02
1E-01
1E+00
1E+01
1E+02
Kinetic Energy, Joule