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MEASUREMENT OF CUTTING POWER DURING WIRE-SAWING OF ROCK IN VACUUM

Abstract

This paper describes measurement of cutting power for the estimation of desired motor torque. In-situ analysis is demanded for the investigation of rock samples in lunar and planetary explorations. Slicing the rock sample is preferable to observe its interior directly. Because coolant cannot use in vacuum environment, a life of a grinding wheel or shaving blade will be shorten. It is expected for a saw wire to keep performance because of successive supply of cutting edges. In popular saw wires, a thin core wire is covered with diamond grits fixed by electroplated nickel. The authors have proposed a desktop wire-sawing machine for cutting experiments in vacuum and performed some demonstrations. In this paper, to estimate the desired motor torque and analyze phenomenon during wire-sawing, the cutting force and power of the saw wire was measured. A self-made wire-sawing machine measures 370 mm x150 mm x200 mm. This machine was installed in a vacuum chamber. A specimen holder is mounted at the end of a cantilever through a two-axis load cell. A thrust force of 0.8 N to press the saw wire was applied with a constant-load spring. The diameter of the saw wire with 30-40-um diamond grits was 0.28 mm. Two bobbins were rotated with two AC servo-motors mounted on the side wall of the vacuum chamber with rotational feedthroughs. The tension and feeding velocity of the saw wire was controlled simultaneously. A basalt rock with dimensions of 15 mm x10 mm x8 mm was used as the specimen. Although the principal force in vacuum was the same as that in air, the removal amount in vacuum was smaller than that in air because of the slip of the diamond grits on the adhered nickel. The cutting power was calculated from the product of the principal force by the feeding velocity of the saw wire. It was proportional to the feeding speed both in air and vacuum below a feeding velocity of 1 m/s. The normalized principal force by the thrust force which is equivalent to the friction coefficient was about 0.5. The maximum torque was 0.2 Nm in the experiments.