A new experimental method to estimate chemical reaction rates in vapor clouds

Sohsuke Ohno[1]; Seiji Sugita[2]; Toshihiko Kadono[3]; Ko Ishibashi[1]; George Igarashi[4]; Takafumi Matsui[5]

[1] Earth and Planetary Sci., Univ. of Tokyo; [2] Dept. of Complexity Sci. & Eng., Univ. of Tokyo; [3] IFREE; [4] Lab. for Earthq. Chem. Univ. of Tokyo; [5] Grad. Sch. of Frontier Sci., Univ. of Tokyo

http://impact.k.u-tokyo.ac.jp/~oono/

A hypervelocity impact is one of the most common and important geologic processes in the history of the Earth and planets. Impact vaporization, in particular, may have played a critical role in the evolution of surface environment of planets (e.g., the killing mechanism of the K/T impact event and the evolution of the Martian atmosphere). However, these problems have not been understood very well yet, because the final chemical compositions of impact-induced vapor are not known. This is largely because there is no established experimental method to measure the chemical reaction rates in high-temperature and high-pressure impact vapor clouds. Thus, the goal of this study is to establish a new method to estimate the chemical reaction rates in vapor clouds.

We propose a new method to estimate the chemical reaction rates in vapor clouds. We use quenching of chemical reactions in order to estimate a chemical reaction rate. The net chemical reaction rate is approximately equal to the change in the equilibrium chemical composition in expanding vapor clouds at the quenching temperature. Thus, we can estimate the net chemical reaction rate at the quenching temperature from the change in the equilibrium chemical composition. We also show an application of the method; measurement of the redox reactions of sulfur oxides in vapor clouds. We constructed an experimental system and carried out laser irradiation experiments, high-speed emission spectroscopic measurements, mass spectroscopic measurements, and theoretical calculations. We estimate the net reaction rate of the conversion reaction from SO_2 to SO_3 in vapor clouds. The result of this application suggests that the final SO_2/SO_3 ratio in $CaSO_4$-composition K/T-sized vapor clouds is significantly lower than unity.