Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16348

Elemental Analysis on Individual Nanoparticles in Meteorites using ICP Time-of-Flight Mass Spectrometry

KANOKO KURIHARA, MASAKI NAKAZATO, MAI AKAMUNE AND TAKAFUMI HIRATA

The University of Tokyo

Presenting Author: kurihara1005@eqchem.s.u-tokyo.ac.jp

Chondrite matrix consists of nanoparticles produced either before or at the solar system formation [1]. Some of these nanoparticles survived from alterations through the meteorite formation, and therefore, cosmochemical information concerning both the formation and the transport mechanisms of the nanoparticles can be derived through individual chemical analysis of meteorite nanoparticles [2]. To do this, however, two major analytical challenges must be considered. One is that high-throughput elemental analysis for large numbers of meteorite nanoparticles is highly desired because of small number fractions of the meteorite nanoparticles preserving cosmochemical signatures before the solar system formation. Second is the high-time resolution elemental analysis from individual nanoparticles having different origins. To achieve both the high-throughput and high-time resolution analysis, we developed a new analytical technique using a time-of-flight mass spectrometry-based ICP-MS (ICP-TOF-MS).

In the ICP-TOF-MS, signal intensities for almost all elements can be derived with the time resolution of about 30 μs, which is significantly shorter than the signal duration of single nanoparticles (e.g., 500 μs), suggesting that elemental analysis can be made even from the transient signals emanating from single nanoparticles. However, this results in enormous datasets, making identification and extraction of nanoparticle signals and visualization of data challenging. Hence, we developed a new high-speed data processing software (NP Shooter) [3].

The present technique was applied to elemental analysis of individual nanoparticles presented in Allende CV chondrite. Nanoparticles were collected from matrix of Allende chondrite using a laser ablation in liquid (LAL) technique [4]. The data obtained from total 3809 meteorite nanoparticles demonstrated that the Allende matrix is a mixture of nanoparticles made of olivine, pyroxene, spinel, iron sulfide and Fe-Ni metal, and the chemical compositions of individual nanoparticles can be derived. In this presentation, we will discuss the cosmochemical features of the chondrite matrix based on the chemical and mineralogical features of individual nanoparticles.

References: [1] Buseck and Hua (1993), *Annu. Rev. Earth Planet Sci.*, 21, 255. [2] Bland et al. (2007), *Meteorit. Planet Sci.*, 42, 1417. [3] Kurihara et al. (2022), *Bunseki Kagaku*, 71, 277 (in Japanese). [4] Okabayashi et al. (2011), *J. Anal. Atom. Spectrom.*, 26, 1393.