ELUCIDATION OF CESIUM ABSORPTION MECHANISM OF PLANT OPAL

Sakamoto, Tetsuo / Morita, Masato / Kondo, Toshiharu / Watarai, Kenta

(出版者 / Publisher)
法政大学イオンビーム工学研究所
(雑誌名 / Journal or Publication Title)
PROCEEDINGS OF THE 38th SYMPOSIUM ON MATERIALS SCIENCE AND ENGINEERING RESEARCH CENTER OF ION BEAM TECHNOLOGY HOSEI UNIVERSITY (December 18, 2019)
(巻 / Volume)
38
(開始ページ / Start Page)
19
(終了ページ / End Page)
23
(発行年 / Year)
2020-02
(URL)
https://doi.org/10.15002/00030328

#ELUCIDATION OF CESIUM ABSORPTION MECHANISM OF PLANT OPAL

Toshiharu Kondo*, Kenta Watarai**, Masato Morita*, Tetsuo Sakamoto*,**,#

**Department of Applied physics, School of Advanced Engineering, Kogakuin University*

***Graduate School of Electric Engineering and Electrics, Kogakuin University*

2665-1 Nakano-machi, Hachioji, Tokyo 192-0015 Japan

Abstract: It is known that radioactive cesium is absorbed in plant opal whose main component is SiO_2, and exist in various plants. Rice's plant opal was measured by focused ion beam time-of-flight secondary ion mass spectrometry (FIB-TOF-SIMS) in order to reveal how plant opal absorbs Cs, and it absorbed Cs by physical absorption. It was considered that plant opal which released from un-contaminated forest would be one of the material Cs migrations for the other environment.

I. Introduction

Various radionuclides emitted by the accident of Fukushima Daiichi Nuclear Power Plant on March 2011. Since such radionuclides include ^{90}Sr and ^{137}Cs which has relatively long half-life (about 30 years), long-term pollution is today's and future's problem. And, radioactive material pollution is a complicated problem to Cs migration in environment by air, wind, river and others. [1-3] In the case of plant, it is well known that plants absorb Cs from soil alike K because chemical property of these elements are very similar. [4] To clean up the environment, understanding the behavior of radioactive materials in environment is important and should be revealed.

Inorganic mineral particle which is several 10 μm and mainly composed of SiO_2 exists in plants and called plant opal. And, some reports suggest Cs is absorbed by plant opal. Figure 1 shows Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) mapping results of Cs and Si in rice chaff's plant opal. Cesium was detected the same area as Si. This is a visual evidence that Cs is absorbed on plant opal. In Japan, forest occupies approximately 65%, therefore, there is a possibility that plant opal is one of the materials assumed Cs migration. Nevertheless, plant opal has not been attracted attention as such opinion today. Authors consider that plant opal should be more studied to proceed improving the environment.

ct13087@ns.kogakuin.ac.jp

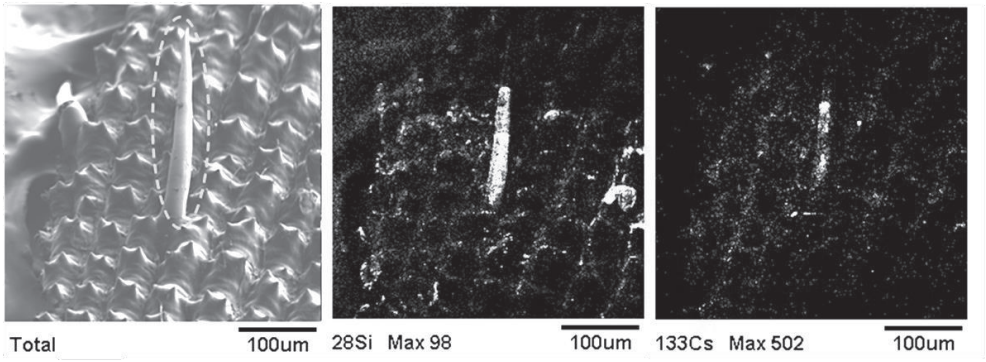

Fig. 1 TOF-SIMS mapping results of Cs absorbed by plant opal

In this work, as the part of revealing plant opal's behavior, Cs absorption process in plant opal was studied. Two kinds of Cs absorbed samples of plant opal were prepared by different processes. And those samples were measured by focused ion beam (FIB) attached TOF-SIMS (FIB-TOF-SIMS) which constructed by our laboratory [5] to reveal how plant opal absorbed Cs and where Cs exists respectively.

II. Experimental

In this study, a Cs-containing solution was prepared and used. The Cs solution was prepared by mixing KCl (Wako Pure Chemical Industries, Ltd., Japan, 4.47 mM) with Cs_2CO_3 (Wako Pure Chemical Industries, Ltd., Japan, 0.5 mM) in water and shacked enough. Two kinds of plant opals of rice reef were prepared to compare the absorption process. Fig. 2 shows sample preparation flowchart of the plant opals. Plant opal was picked up on an Al pellet after a reef was cut a few mm length, ash incinerated by 400°C and shaken off from ash by ultrasonic with water. In the case of the sample which produced physical absorption (hereinafter sample A) was stirred with Cs solution 24 hours after reef ash incinerated by magnetic stirrer to increase contact probability of plant opal and Cs. Another sample's plant opal (hereinafter sample B) was picked up from a reef which was grown by hydroponics in Cs solution to produce bio activity. Each sample was measured by the FIB-TOF-SIMS after enough dried.

Each sample was measured by the FIB-TOF-SIMS which was constructed by our laboratory. This apparatus is suit for micro-particle analysis because accelerated to 30 kV Ga^+ ion is used to primary ion beam and has the highest lateral resolution (40 nm). Furthermore, the FIB is available for micro scale milling and obtaining sample's cross section and analysis.

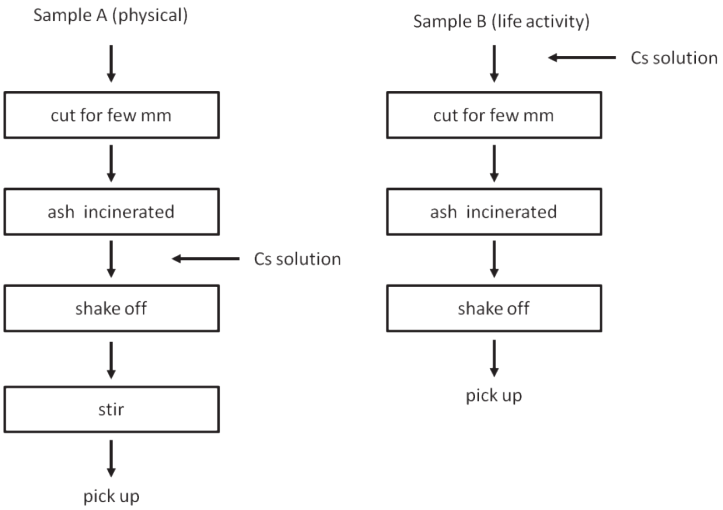

Fig. 2 Flowchart of plant opal picking up method

III. Result and Discussion

Figure 3 shows plant opal after Cs absorption of sample A and B, respectively. TOF-SIMS measurement of sample A and B was performed. The results of component analysis are shown in the Fig. 4. Cs was detected from the same area as Si of both samples A and B. In the case of sample A, to observe the inside, a cross section was fabricated by the FIB (Fig. 5). As shown in Fig.6, Cs was detected from the whole cross section. Those results indicate that plant opal is considered to absorb Cs by physical adsorption. In other words, absorption of Cs into plant opal does not depend on whether the plant lives. Furthermore, it is considered that plant opal from un-contaminated forests can also contribute to the environmental migration of Cs.

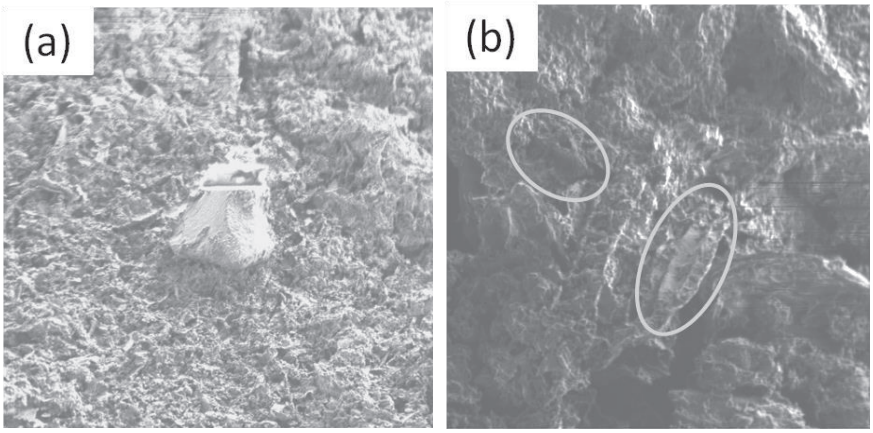

Fig. 3 Plant opal measured by FIB-TOF-SIMS; (a) sample A, (b) sample B

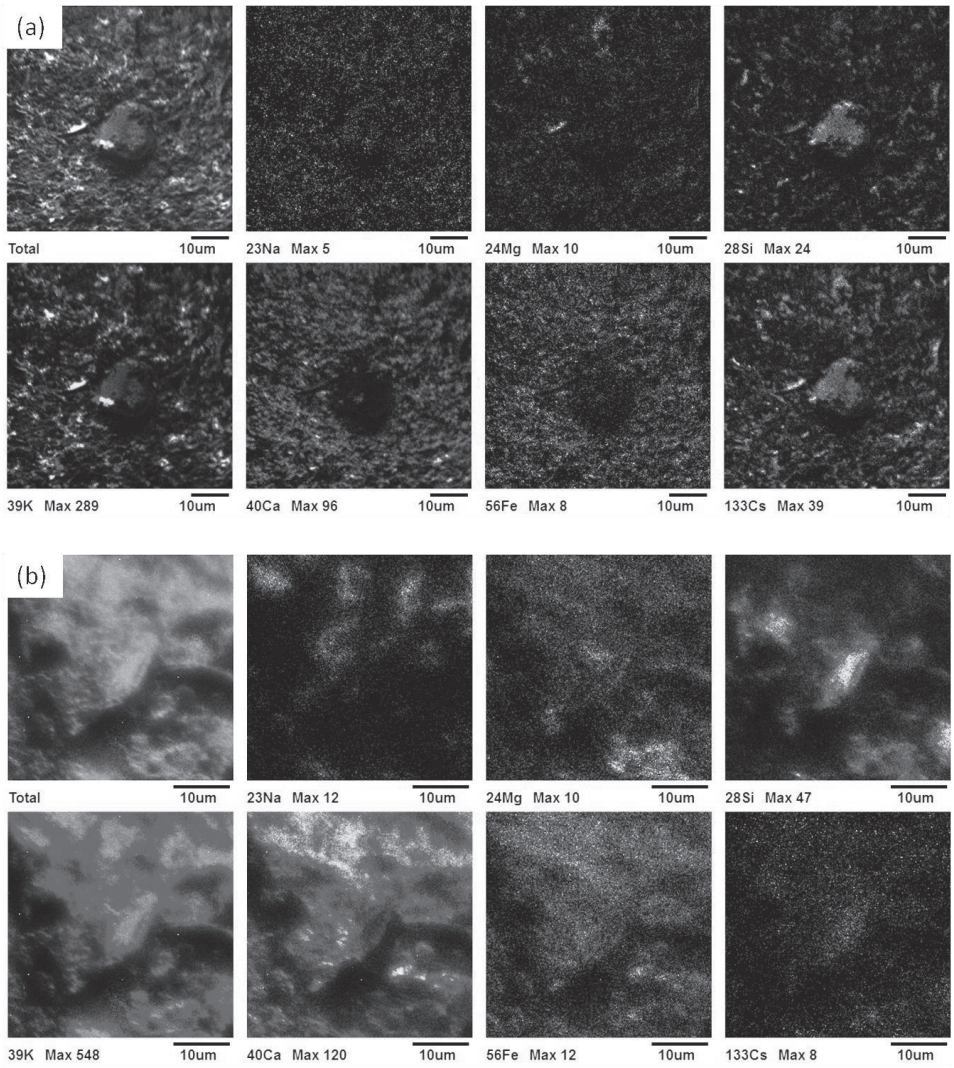

Fig. 5 TOF-SIMS results; (a) sample A, (b) sample B

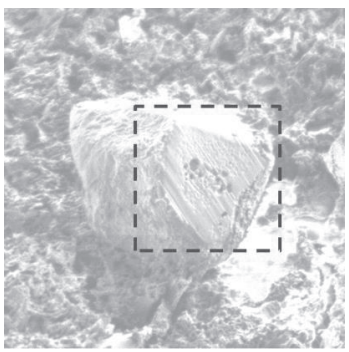

Fig. 4 FIB milling for obtaining cross section of sample A: inside of red dotted line indicates cross section milled by FIB

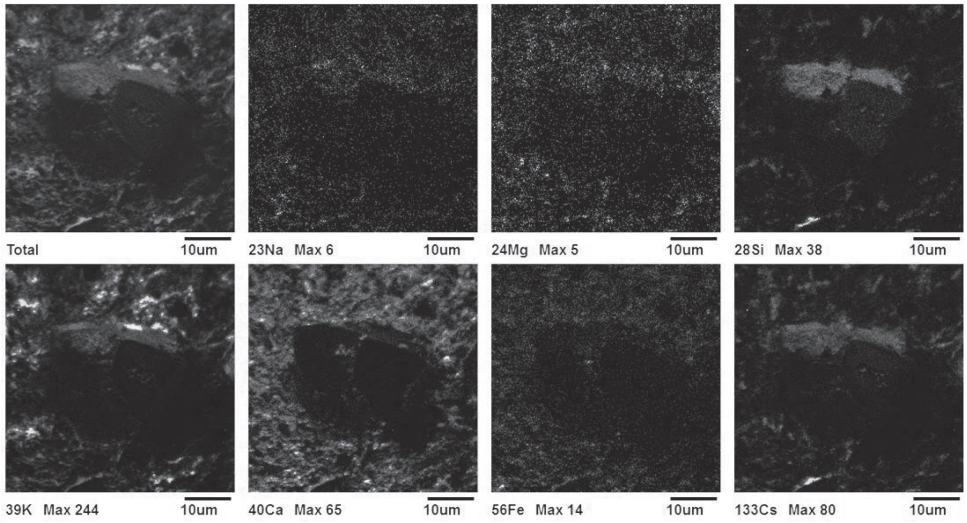

Fig. 6 Cross section of sample A after cross-sectioning by FIB

IV. Conclusion

Comparison of plant opal's absorption process of Cs was carried out. As the results, Cs was detected from the surface and whole cross section. We decided that Cs absorption by plant opal not depends on plant's life activity. And plant opal was considered to it should be attracted more attention as one of the Cs migration material.

Acknowledgement: This study supported by "Development of System and Technology for Advanced Measurement and Analysis" SENTAN, JST.

References

1) S. Kaneko *et al.*, *Japanese Society of Soil Science and Plant Nutrition,* **85**(2), 86 (2014) (in Japanese).
2) T. Kajimoto *et al.*, *The Japanese Forest Society*, **97**(1), 33 (2015) (in Japanese).
3) K. Saito *et al., Journal of Environmental Radioactivity*, **139**, 240 (2015).
4) H. Tsukada, *CHEMISTRY*, **67**(11), 20 (2012) (in Japanese).
5) T. Sakamoto *et al.*, *Applied Surface science.*, **255**, 1617 (2008).