

論文 / 著書情報
Article / Book Information

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Title(English)	Study on Remote Elemental Analysis System for Aqueous Solutions using Sonoluminescence
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

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Department of, Graduate major in Nuclear engineering

系
コース

申請学位 (専攻分野) : 博士
Academic Degree Requested Doctor of (Engineering)

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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

This dissertation focuses on a study on a qualitative remote elements analysis system using a well-known ultrasonic phenomenon, namely sonoluminescence (SL), which emits light with specific wavelengths depending on the elements of the targeted aqueous solutions. The study's basis is that after the TEPCO's Fukushima nuclear power plant accident, the contaminated water remains one of the crucial problems. The harsh condition inside the reactor complicates the challenges; among the existing quantitative elemental analysis that requires sample transportation to outside the reactor, a complementary remote elemental analysis is required. The dissertation aims to study the feasibility of developing the remote elemental analysis using SL.

In Chapter 1, "Introduction." The reasoning behind the study, objectives, dissertation outline, and dissertation scope are explained.

Chapter 2, "Sonoluminescence Characteristics in Closed Condition into the Use for Elemental Analysis", explains the essential characteristics of SL for its uses in elemental analysis. In this study, the experiment was conducted using a bath-type ultrasonic transducer for analyzing various elements. Photographs of each element were taken in dark environments using a still camera with a long exposure technique. An image analysis algorithm was developed, mainly for color categorization of the experiment results. The image categorization algorithm was developed based on HSV (hue-saturation-value) color scheme. The image taken allowed 2-dimensional observations of SL behavior. The chapter contains demonstrations of SL showing the standing wave pattern under ultrasound sonication. Further test on the relation between solution concentration and SL intensity, proportional relation was obtained. Also, the parametric study showed that the SL intensity increases with the increase of ultrasonic frequency and power, and the continuous injection of argon gas extended the detection limit. Furthermore, for elemental analysis, SL shows specific colors for each element, confirming the feasibility of qualitative elemental analysis.

Chapter 3, "Sonoluminescence Characteristics in Open Condition with Mobile System using an External Transducer". Although the SL shows the potential for use as elemental analysis in the previous chapter, the relatively big bath-type transducer is impractical. Therefore, this chapter aims to fulfill one of the requirements to enable remote analysis: mobile ultrasonic transmission to produce SL. The study mainly focuses on analyzing the performance by constructing a mobile ultrasonic transmitter system using an external transducer. In this chapter, the open environment effect, the direct

solution contact, and the size of the containers were studied. The results show that SL characteristics generated in this condition with the parameter changes are similar to those in the closed system. The visualization of SL of various elements using an external transducer was reported that the standing wave was still observed and the color obtained was the same. However, slightly higher uncertainties such as intensity and color distribution were observed compared with the closed system. Furthermore, the existence of flow inside the reactor is inevitable; therefore, the versatility test of the SL behavior with the presence of flow is investigated. Photograph results showed a broadening of SL emissions points due to the flow of the solutions. Furthermore, an investigation of the SL process on the flow was conducted with an ultrasonic velocity profiler (UVP). The result showed that disturbances in the flow were observed with the SL operation. SL power, flow rate, and distance between the SL and UVP system highly affecting the flow disruption. The optimum combination of flow rate and the SL power was also evaluated, and it can be concluded that the operating area of the current setup is in laminar and transitional flow conditions.

Chapter 4, "Evaluation of Remote Elemental Analysis System for Aqueous Solutions using Sonoluminescence". This chapter aims to clarify the feasibility of the remote elemental analysis system for aqueous solutions using sonoluminescence. The remote ultrasound transmission using an external transducer and light analysis using optical lenses and optical emission spectrometer were combined. The SL spectrum analysis system was performed based on the standard principle of an optical emission spectrum analysis to analyze the chemical components of the solution. The analysis of various elements showed that the peaks are in good agreement with the wavelength presented in the reference. Also, light transmission using optical fiber fulfills one of the requirements of remote analysis, which is to analyze the SL emission remotely. Further study on the limit of detection of the current setup is in average approximately 7 g/l with average yield approximately 8%. Although the limit of detection is relatively high and the lower yield, the findings in this dissertation satisfied the purpose of the dissertation and fall under the specified scope of the study. This being said, the feasibility of the qualitative remote elemental analysis system for aqueous solutions using sonoluminescence was clarified.

This study provides recommendations related to the use of sonoluminescence for remote elemental analysis for engineering and provides industrial merits. In chapter 5. "Conclusions" Overall achievements of the dissertation and conclusions from each chapter were summarized. The summary includes the results, limitations, and recommendations for possible improvements.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1 copy of 800 Words (English).

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