# Mapping Program of Irradiated Nuclear Fuel for Radioanalytical Chemist

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## 1. Introduction

A high burnup nuclear fuel requires an experimental database to support the fuel integrity, a safety analysis, and a shielding design. Therefore, as a part of the "Nuclear Technology Development Project", we have investigated the local burn-up properties of highly burnt nuclear fuels to make a database that can be used for evaluation of the fuel integrity and the verification of fuel performance code. In this study, a mapping program of a fuel rod using the obtained chemical data was developed and named “ChemMAP-INFRA”. This provides information about the local burnup, and radial and/or axial distribution of isotopes in a fuel rod.

## 2. Methods and Results

The local burnup characteristics at high burnups, the changes of isotopic ratio in a nuclear fuel throughout the radius were determined using a radiation shielded LA-ICP-MS system. The object of this program was to provide basic tools to effectively manage the obtained data. For convenience, this program can be operated under a Windows system (above XP).

### *2.1 Data Input*

In our previous work[1], we measured the radial distribution of isotopic ratio (actinides isotopes against $^{235}$U) at a certain axial point of a fuel rod. A ChemMAP-INFRA uses those measured data as input in Fig. 1. The measured value has its designated color and gives a color gradient between the two measured points.

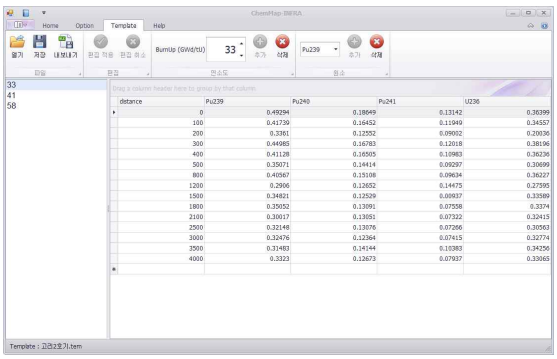

Fig. 1. Input data of isotopic ratio against $^{235}$U.

### *2.3 User-friendly tool*

For convenience, each user can add a position of data points in a fuel rod, measured value, nuclei and isotopes, and average burnup. It provides a tool for storage and an effective maintenance of the experimental data.

Fig. 2. User-friendly toolbar.

### *2.2 Axial and Radial Distribution of isotopes*

The output is represented as a contour map with the color change shown in Fig. 2. For an axial distribution, two types of maps (which represent surface and cross section of the fuel rod) are possible. When we click a specified axial position, we can observe the average burnup and radial distribution of the intended isotopes at this position. It can predict the values of the unmeasured spot from the neighboring measured spots by the color gradient. If we can provide more experimental data, the map may approach closer to the real profile.

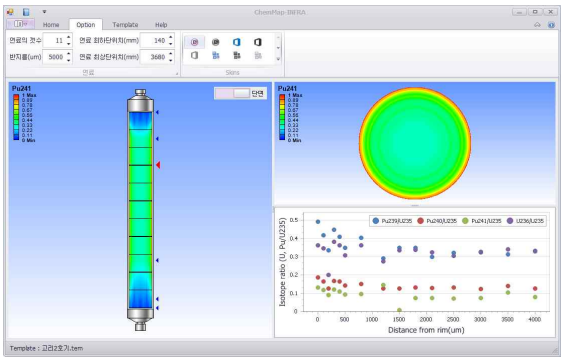

Fig. 3. Contour map of $^{241}$Pu/$^{235}$U distribution in a spent fuel rod: (left) axial cross section (top right) radial cross section, (bottom right) experimental data.

From the radial cross section (top right) in fig. 2, we can observe a sharp color change near the fuel surface, which represents a remarkable increase in the rim region (so-called 'rim effect').

## 3. Conclusions

The developed ChemMAP-INFRA can be a useful tool for a chemist to manage the experimental data effectively. The output gives a better understanding of the irradiation behaviors of the fuel. It provides an estimate of the local burnup properties of a fuel rod. Further studies are underway to correct any inconveniences and improve the program more effectively.

## Acknowledgements

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIP) (No.2012M2A8A5025925).

## REFERENCES

[1] Yeong-Keong Ha, Jungsuck Kim, Young Shin Jeon, Sun Ho Han, Hang Seok Seo and Kyuseok Song, Local Burnup Characteristics of PWR Spent Fuels Discharged from Yeonggwang-2 Nuclear Power Plant, Nuclear Engineering and Technology, Vol.42(1), p. 79, 2010.