Medical Application (SR-XRF group)

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1. Introduction

The analysis of the trace elements in biological samples requires a development of XRF techniques with ultra high sensitivity and high spatial resolution, together with capability in nondestructive, nonvacuum, and simultaneous multielemental analyses. In order to fulfill these requirements, we plan to use two analytical techniques at BL39XU: one is the total reflection X-ray fluorescence (TXRF) analysis and the other is X-ray microbeam analysis. We expect sensitivity of fg or ppb and X-ray microbeam with submicron size. We had a chance to carry out a TXRF experiment at BL39XU in 1997. This paper reports its preliminary result. SR-XRF analysis of biological and medical samples will represent an important step in understanding the role of trace elements in biological systems.

2. Experimental system

We have constructed a new total reflection analysis system for medical samples. Figure 1 shows a photograph of the analysis system installed at BL39XU. It is composed of vacuum chamber for analysis of light elements such as Al and P, Pure-Ge S.S.D. as a detector suitable for the light element analysis, and x,y,θ pulse stages for total analysis, and two dimensional analysis. The characteristic of this system is a vertical detector geometry with a horizontal sample holder. This system allows us to obtain the highest fluorescence signal from a flat sample under total reflection mode though the scattering might be high. The measurements were carried out at BL39XU using undulator beam of 17.5keV. The undulator gap was 27.2mm. Samples examined were selected from a viewpoint of preliminary analysis to clarify the potential of this system and the beam line as well. The standard samples used were Bovine Liver (NIST standard reference material 1577B) and river water (Analytical Society of Japan: JAC0031) and actual samples were composed of water of Arima Hot Spring, river water in Tokyo, moat water of The Imperial Palace, and tissue of bladder carcinoma. The biological samples were digested with acid while water samples were used without any pre-treatment.

3. Analytical Results

Here we present some preliminary results of the analysis obtained by the new TXRF system. Figure 2 shows a TXRF spectrum of standard river water. The amount of the sample required was 10µl. The certified values for Pb, Se, Zn and Ca in 10µl sample solution are 0.26, 1, 7.9pg and 125ng, respectively. It can be seen from Fig. 2 that this technique has high sensitivity up to fg region. The spectrum of the water of Arima hot spring (fig. 3) exhibited characteristic heavey elemetn-contents of Br, Rb and Sr in pg to ng levels. The present study has revealed that the analysis of trace elements in pg ot fg levels in environmental waters is possible with 10µl sample and without pre-condensation. On the other hand, to examine the performance of this technique in the medical applications, the samples of digested bovine liver standard and carcinoma tissue were examined. Figure 4 shows a spectrum of the bovine liver: the certified values for Pb, Br, Rb and Sr in the sample (360 µg) are 0.064, 3.5, 4.93 and 0.049ng, respectively. The amount of the sample required for the analysis is less than 1 mg. This enables us to carry out trace element analysis of biopsy samples, which will reveal the dynamical behavior of trace elements in carcinoma tissues, such as time dependent level of trace elements at different progress stages of carcinoma and the correlation among the various trace elements.

4. Activity in 1997

Our publications for SR-XRF analysis of biological samples are listed in the references.

5. Plan for 1998

The present data are only semiquantitative. Quantitative data will be obtained from the next experiment in 1998. X-ray microbeam analysis is another important subjects, which will be done using the experimental system currently constructed by Spectrochemical Analysis group.

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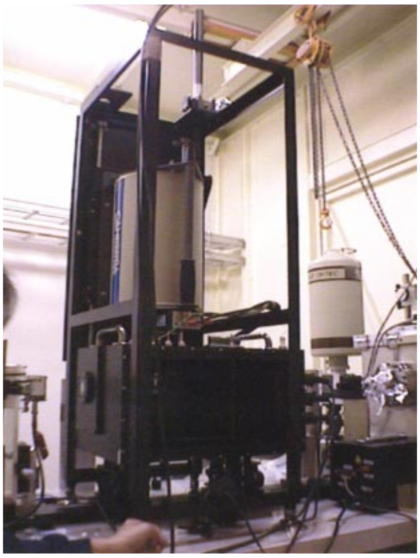

Fig.1. Overview of the experimental system for TXRF measurements at BL39XU.

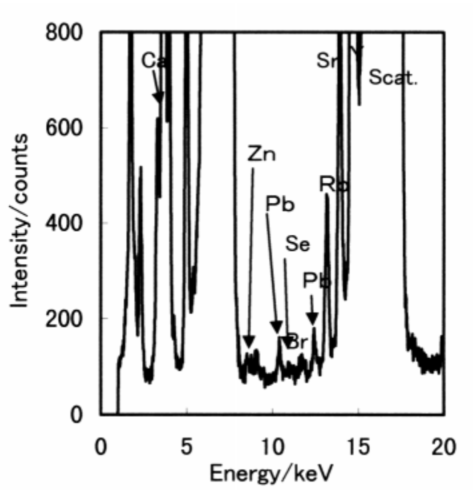

Fig.2. TXRF spectrum of standard river water (JAC003: sample 10µl)

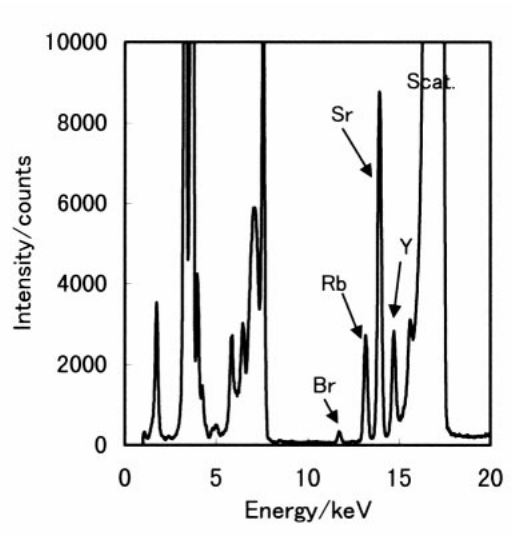

Fig.3. TXRF spectum of water of Arima Hot Spring (sample 10µl)

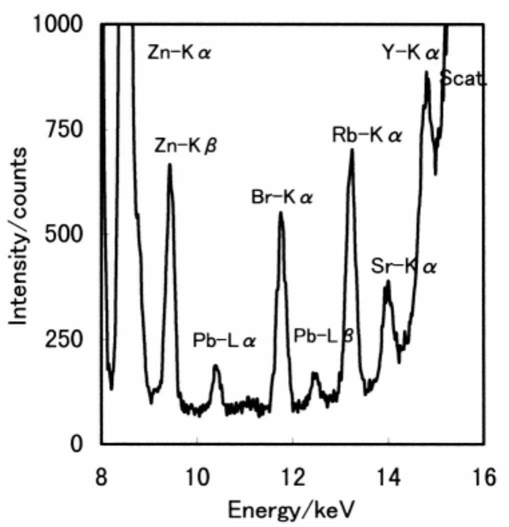

Fig.4. TXRF spectrum of bovine liver (SRM1577b: sample 360µg)