QUANTITATIVE ANALYSIS OF METAL ELEMENTS IN LEAVES BY XRF
USING THE FUNDAMENTAL PARAMETER TECHNIQUE

Hiroshi SAKATA, Ikuko YAMAMOTO, Makoto SONE, Michio MATSUBARA

Seiko Instruments Inc.
Kameido 6-31-1, Koto-ku, Tokyo 136, JAPAN

Abstract The fundamental parameter technique (FPT), that does not need standard sample for quantitative analysis, is a very convenient method. However, it is difficult to use the FPT for the quantitative analysis of organic samples. If the matrix light elements are specified as the balance element, the mass attenuation of the matrix can be estimated. And it is suggested that the FPT can be used for quantitative analysis of metals in organic samples. When the cellulose formula ($C_6H_{10}O_5$) was specified as the balance element formula, and FPT was used for quantitative analysis method, the obtained values to analyze the reference materials of leaves by XRF agreed with the certified values.

Key words XRF, fundamental parameter technique, mass attenuation

INTRODUCTION

J. Sherman¹⁾ specified the fundamental equations of XRF emission and that the fundamental parameters and the theoretical calculations were possible to use for the quantitative analysis by XRF. T. Shiraiwa and N. Fujino²⁾ specified in consistency of these equations and modified the equations.

This quantitative analysis technique, call the fundamental parameter technique(FPT), is a very convenient method, for no standard sample is necessary. However, it is difficult to use the FPT for quantitative analysis of organic samples. Because the major matrix elements of the organic samples, C, H, O and N, have very poor sensitivity, and the detection of these elements is very difficult, considering that all of the contained elements in the sample should be identified to determine the mass attenuation of the sample.

T. Ui et al.^{3),4)} specified that the mass attenuation of the matrix, which is one kind of the fundamental parameters, can be estimated by the measuring of Compton scatter intensity, and introduce the attenuation correcting equation. However, these technique had a problem that the equation was applicable only to the heaviest element in the sample.

But the mass attenuation of the light matrix can be estimated also by the specification of matrix composition as the balance element. In the case of this technique, the measurement of Compton scatter intensity is not necessary, and all the contained elements can be analyzed.

The measurement results of leaves samples by using this technique will be reported on this presentation.

FUNDAMENTAL PARAMETER TECHNIQUE

Employed fundamental equation was originally improved, based on a modified and improved equation by T. Shiraiwa and N. Fujino. This equation calculate the secondary fluorescent X-ray, and is used for bulk samples only.

EXPERIMENTAL

Instruments The SEA-2001 (Seiko Instruments Inc.) was used as the fluorescent X-ray spectrometer. The SPS-1200VR (Seiko Instruments Inc.) was used as ICP-AES spectrometer. ICP-AES was used for the cross-check of un-known sample data.

Samples Pepperbush, Chlorella, Tea leaves (above NIES reference materials). and tomato leaves (NIST reference material) were used as known samples.

Sample Preparation All of the measuring samples were dried powders. Therefore, these samples were pressed with the water press, and formed to 20mm ϕ size pellets.

Measuring Conditions

Table 1 Measuring conditions

I t e m s	V a l u e s
Aperture	3mm ϕ
Tube High Voltage	15kV
Tube Current	250 μ A
Tube Target Material	Rh
Tube Be Thickness	200 μ m
Measuring Pass	Vacuum
Measuring Time	1200sec.
Live Time	970-1020sec.

RESULTS

The following results were obtained. All of these samples are leaves samples. Therefore, the cellulose formula is specified as the balance element formula. It is suggested that the mass attenuation estimation by specifying the light matrix element as the balance element is able to quantitatively analyze the metal contents by using the FPT.

Table 2 Analytical results of known samples

Element	Pepperbush		Chlorella		Tea Leaves		Tomato Leaves	
	Certi-fied	FPT	Certi-fied	FPT	Certi-fied	FPT	Certi-fied	FPT
Mg	0.41 %	0.12 %	0.33 %	0.34 %	0.15 %	0.00 %	0.7 %	0.41 %
P	0.11	0.12	1.7	2.62	0.37	0.51	0.34	0.52
K	1.54	1.54	1.24	1.37	1.86	1.86	4.46	3.81
Ca	1.38	1.27	0.49	0.50	0.32	0.26	3.00	2.37
Mn	0.20	0.21	0.007	0.009	0.070	0.075	0.024	0.021
Fe	0.021	0.022	0.19	0.24	-----	0.011	0.069	0.055
Co	0.0023	0.002	0.0001	0.0006	0.0000	0.0002	0.0001	0.0008
Zn	0.034	0.037	0.002	0.002	0.0033	0.003	0.006	0.004

----- : Not tested

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