Application Brief
SII

SII NanoTechnology Inc.
RBM Tsukiji Bldg.
Shintomi 2-15-5, Chuo-ku, Tokyo 104-0041, Japan
URL：http://www.siint.com

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# Introduction to the Thin Film FP Method

## 1. Overview

The SFT series is an instrument the finds film thickness layers based on fluorescent X-ray intensity data obtained by exposing a sample to X-ray irradiation. The calibration method has been typically used as the method of converting fluorescent X-rays intensity to film thickness. Figure 1 shows that the calibration method is a standard that measures a standard sample of known thickness, finds the relationship of fluorescent X-ray intensity with film thickness as a calibration curve, and converts fluorescent X-ray intensity to film thickness.

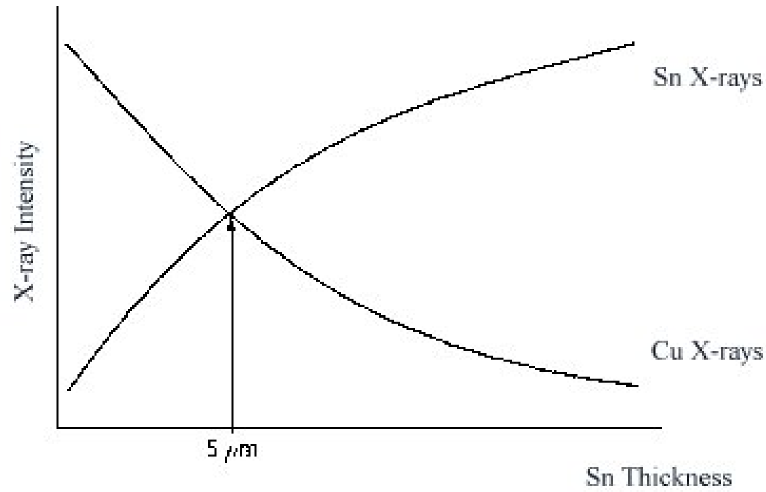
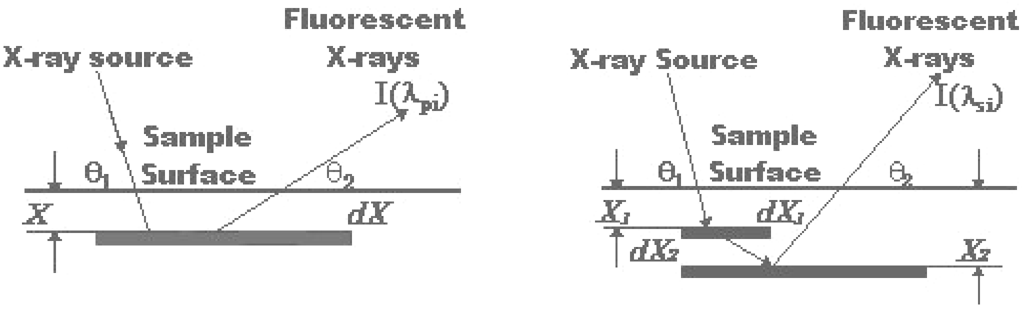



Figure 1

More recently, the Fundamental Parameter (FP) Method has been used as a new quantitative method for converting fluorescent X-ray intensity data to film thickness.

## 2. FP Method

If a sample is analytically uniform, analytical intensity can describe the sample composition and fundamental constant (fundamental parameter) as a function. In other words, the intensity produced from a sample of any composition can be calculated from this fundamental constant.




**Primary Fluorescent X-rays**

**Secondary Fluorescent X-rays (Excitation Effect)**

Figure 2 Analytical rays generating mechanism by excitation effect

The figure above displays a model of how fluorescent X-rays are generated. Fluorescent X-ray intensity and actual values theoretically analyzed and obtained from this model show good agreement. Quantitative analysis based on these facts is called the FP method.

If the depth at which fluorescent X-rays are generated is infinite in terms of X-rays, then the FP method can be applied to bulk samples, and if depth is a small value (less than the critical thickness) then the FP method can be applied to thin film samples. A major characteristic of the FP method is the ability to simultaneously measure composition and thickness of thin film samples from composition analysis of bulk samples. The SFT3000S series has a bulk FP method for analyzing bulk samples and a thin film FP method for analyzing thin film samples.

## 3. Advantages of the FP Method

This section lists advantages of the FP Method.

***FP Method measurement is possible by preparing infinite thickness samples of elements of which the sample is composed.***

For example, a semi-quantitative measurement is possible when measuring a Au/Ni/Cu application if infinite samples are prepared for Au, Ni, and Cu.

Furthermore, measurement equal in accuracy to the calibration method is possible by preparing a minimum one point standard sample of known thickness (One Standard Correction) of Au/Ni/Cu. The calibration curve method requires that the calibration curve be created using 10 standard samples. The FP method requires using 4 standard samples and measures at equal performance.

***The FP Method lets you perform simultaneous measurements of multi-layered thin films, including alloys, that cannot be measured using the calibration method.***

***Thin film thickness and composition can be measured with the FP Method if infinite thickness samples are prepared for elements that make up the sample.***

## 4. Calibration Curve Method and FP Method

The following table is a comparison of the Calibration Method and FP Method.

| Application | Quant. Method | Description | Number of Standards |
|---|---|---|---|
| Single Layer | Calibration | Yes | Minimum 3 |
| | FP | Yes | Minimum 3 |
| Mulit Layer | Calibration | Up to 2 layers | Minimum 10 |
| | FP | Up to 4 layers | Minimum 4 |
| Alloy | Calibration | 2 elements | Minimum 8 |
| | FP | Multi layer including alloy layers | Minimum 4 |
| Bulk | Calibration | Multi element alloy | Minimum of 5<br>(3 elements) |
| | FP | Multi element alloy | Minimum of 4<br>(3 elements) |

Alloy multi-layer film thickness, composition, and middle layer, such as Sn-Pb/Ni/Cu can be simultaneously measured. An electroless middle layer application such as Au/Ni-P/Cu can also be measured.

## 5. Summary

A major advantage of the FP Method compared to the Calibration Method is its measurement capability equal to that of the Calibration Method but with fewer samples. Also, it expands the range of measurement for film samples of complex compositions that cannot be measured by the Calibration Method.