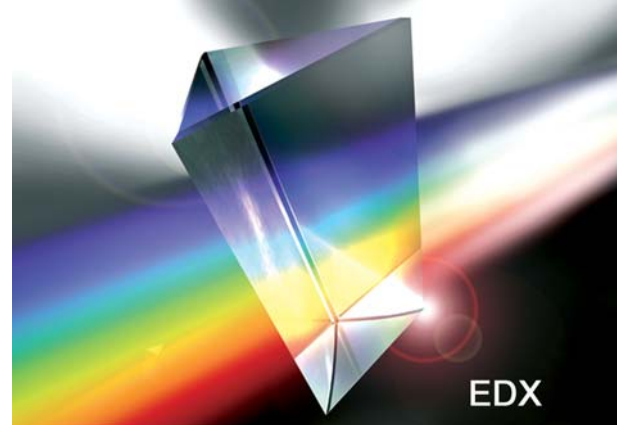


Application Note



EDXRF Analysis of Polymer Film

Determination of Thickness, Determination of Both Thickness and Concentration

Shimadzu's original "Background FP Method" (hereafter referred to as the "BG-FP method") is effective for determining the thickness of polymer films such as polyethylene and polyester. This method incorporates X-ray scattering theory calculation into the FP method. By applying the principle that the intensity of the Compton scattering lines made by a polymer film is proportional to its thickness, the thickness of the film can be determined in air at the same time as content of its constituent elements. Shown below are two examples of this.

Sample

- Polyester film 6 μm , 12 μm , 25 μm
- Polyethylene film including inorganic elements 200 μm

Sample Preparation

The sample is submitted for testing without prior preparation.



Fig.1 Sample Loading

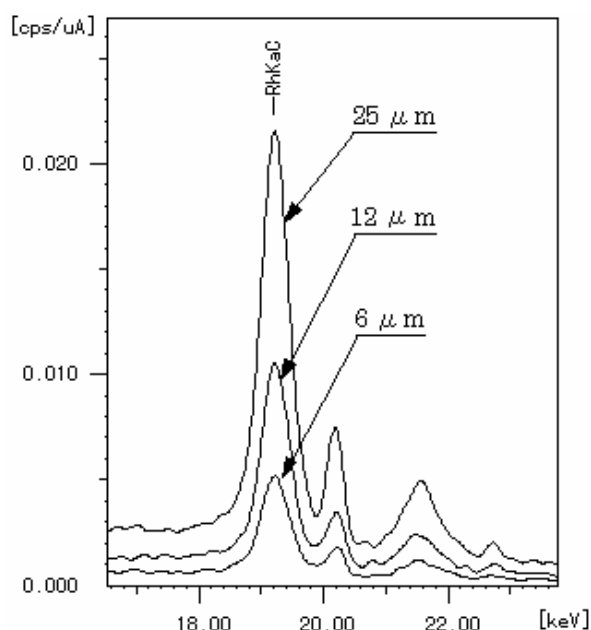


Fig.2 RhKa Compton Profile of Polyester Films

Qualitative Analysis of Polyester Films

In the BG-FP method of polymer film thickness determination, the Compton scattering lines of the "characteristic" X-rays of the X-ray tube target (Rh) is measured. The RhKa Compton scattering profiles of the 3 polymer films of differing thickness is shown superimposed on the same graph in Fig. 2. From this it can be seen that the intensity of the RhKa Compton scattering lines becomes greater as the thickness of the film increases.

Determining the Thickness of Polyester Films

The results of the thickness determination analysis by BG-FP method are shown in Table 1. In order to calculate the film's thickness the density of the film is required. In this case the 1.39 g/cm³ density of polyester is used. In addition it was assumed that the composition of the film was C₁₀H₈O₄.

Table 1 Thickness Determination of Polyester Films by Background FP Method

Sample	Chemical Formula	Film Density	Determined Value	Reference Value	by Micrometer
Polyester Films	$(C_8H_{10}O_4)_n$	1.39 g/cm ³	7.2 μm	6 μm	7-14 μm
			14.5 μm	12 μm	14 μm
			29.7 μm	25 μm	26-30 μm

Determination of Both the Thickness and the Concentration

The thickness of polyethylene that includes the elements Cr, Mn, Fe, Co, Ni, Cu and Zn was determined at the same time as the content of the elements within the polyethylene.

The quantitative profiles are shown in Fig. 3, while in Table 2 the values calculated from the quantitative profiles by the BG-FP method is

shown together with their equivalent area density (30 mmφ) conversion values and standard values. Note that the major was assumed to be polyethylene (CH₂)_n and used as the balance(residue balance), while the density of the film was assumed to be that of polyethylene (0.92 g/cm³).

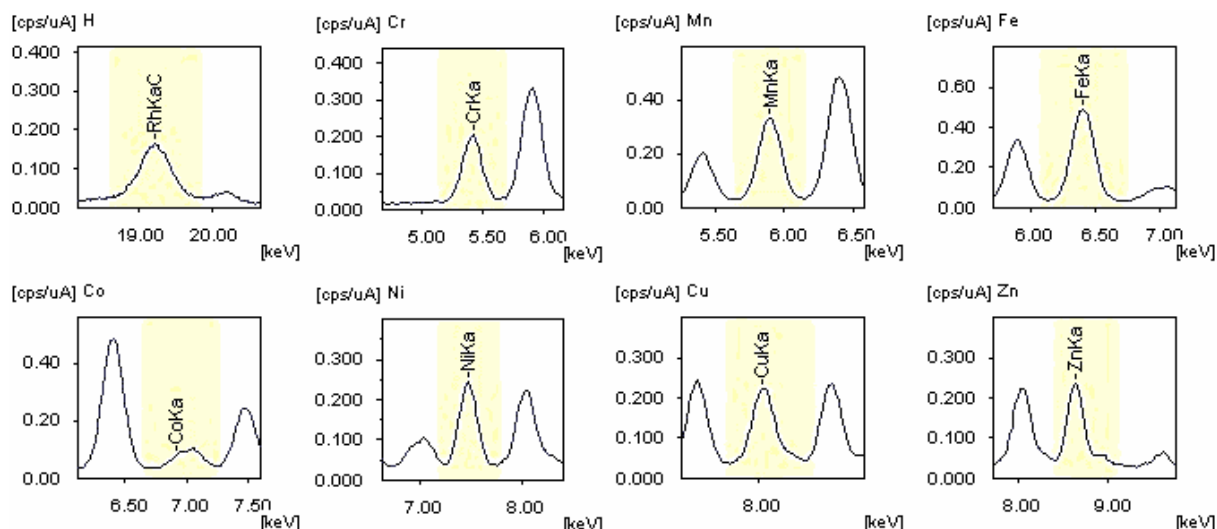


Fig.3 Profiles of Polyethylene Film for Quantitative Analysis

Table 2 Determined Thickness and Concentration of/in Polyethylene Film by Background FP Method

Sample	Film Density	Determined Value		Standard Value				
		Cr	Mn	Fe	Co	Ni	Cu	Zn
Polyethylene Film including Inorganic Compounds	0.92 g/cm ³ ((CH ₂) _n)	91 μg/30 mmφ	(645 ppm)	100 μg/30mmφ	(769ppm)			
		297	(2096)	300	(2307)			
		219	(1546)	200	(1538)			
		21	(149)	20	(154)			
		87	(612)	100	(769)			
		85	(598)	100	(769)			
		88	(620)	100	(769)			
	Thickness	218 μm		200 μm				

Analytical Conditions

Instrument: EDX-700
 X-ray Tube: Rh target
 Filter: not used
 Voltage - Current: 50 kV – 77 μA (Auto)
 50 kV - 446 μA (Auto)
 Atmosphere: Air
 Measurement Diameter: 10 mm
 Measuring Time: 100 sec
 Dead Time: 24 %

References

- Shimadzu Application News X-ray Analysis No.175,176 "The Application of Background FP Method"(1),(2).
- Shimadzu Application News X-ray Analysis No.190 "The Measurement of the Thickness of a Polymer Coat on a Steel Plate Using the Theoretical Intensity of the Compton Scattering X-rays".

The given specifications serve purely as technical information for the user. No guarantee is given on technical specification of the described product and/or procedures.