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A New X-ray Scattering Technique for the Analysis of the Low-Z Materials

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1. Introduction

X-ray scattering technique has been using as a quick analytical tool for the analysis of composition of materials. It has the advantages of non-destruction, rapid analysis, and good accuracy. So many researchers have been studying about analytical methods and applications using X-ray spectrometry [1-4].

In the X-ray spectrometry, Compton scattering occurred by the low-Z elements like hydrogen, carbon or oxygen have a strong influence on the matrix effects and therefore Compton scattered X-ray are used for matrix correction in determination of several physical quantities such as electron momentum distributions in atoms, molecules and solids, and thickness of material.

The aim of this work is to develop a new analytical technique using Compton scattered X-ray peak under various experimental conditions. In this study, X-ray scattering technique is introduced as an alternative method for the determination of thickness of polymer film and water content in a sample because the intensity of Compton scattered characteristic X-ray peak is proportional to amount of the low-Z materials such as organic polymer and water.

2. Methods and Results

2.1 Experimental Setup

X-ray experiments were carried out using a wavelength-dispersive X-ray fluorescence spectrometry (WD-XRF). The operating conditions of WD-XRF for the analysis of polymer film thickness and water content in sample are given Table 1.

Table 1: The operating Condition of WD-XRF

Tube Voltage / Current	60 kV /50mA
Mask size	30 mm
Collimator	0.15°
Analyzing crystal	LiF 100
Detector	FC + SC

The intensities were determined for of polymer film thickness and water content in sample by the measurement of radiation of Rh Compton line in the analyzed samples.

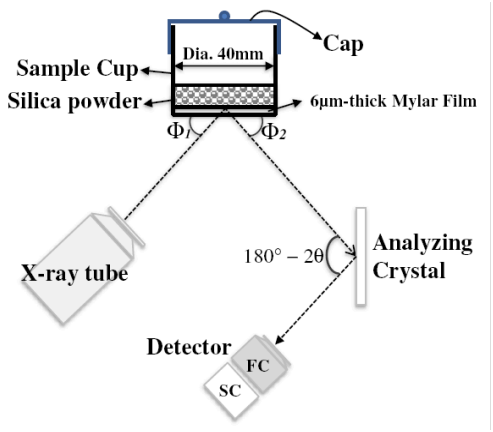

Fig.1. Schematic diagram of a WD-XRF composed of X-ray source, sample, crystal and detectors [5]

2.2 Sample Preparation

Fig.2 shows image of polymer film and silica power used in experiment. For film thickness analysis, Polymer film used is an adhesive film. Polymer film has a about 50μm thickness, polymer film was coated from one to five layers on the metal. For water content analysis, silica powder was synthesized by the surfactant-templated synthesis method. Water of 0 to 61.5 wt% was added to the silica powder in each bottle and sealed well.

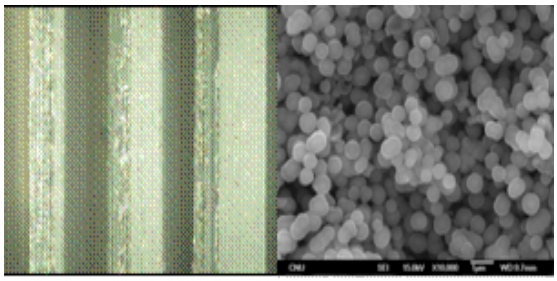

Fig.2. Image of polymer film and silica powder

2.3 Physicochemical Measurements

In Fig.3, Rh K_α and K_β lines are observed in the fluorescence spectrum, caused by Rayleigh scatter of tube radiation. Rh K_α and K_β Compton scatter lines are also observed, shifted to a lower energy compared with Rh K_α Rayleigh peak were measured at $2\theta = 17.53$. The center of the Compton peak was located at $2\theta = 18.6$.

An analysis of polymer film and water contents are based on the observation that the intensity of the Compton scatter peak is proportional to film layer numbers on metal surface and water content in silica powder. This may be applied by simply normalizing all fluorescence measurements from a sample to the intensity of the Compton scatter line derived from one of the characteristic fluorescence lines from the X-ray source. The intensity of Rh K_α and K_β Compton scatter lines increased with the increase of the number of the polymer layers and water content.

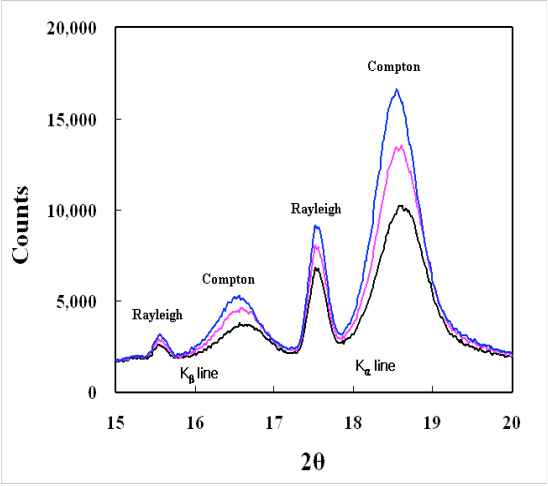

Fig.3. A representative X-ray fluorescence spectra of Rh. The scan is plotted against increasing spectrometer 2θ angle, a parameter that is inversely proportional to decreasing X-ray photon energy

3. Conclusions

We described a new approach for potential of Compton scattered x-ray covering a wide distribution and range of water content and polymer film thickness as a reliable quantitative method. We used the commercial X-ray fluorescence spectrometer to obtain Compton-scattered characteristic X-rays from the target and detect the scattered X-rays without any modification. The intensity of Compton scattered X-ray from an anode target was directly proportional to polymer film thickness and water content in samples. This is relatively convenient and more suitable for on-line applications such as process control and monitoring. Also this technique would be a very attractive non-contact and a non-destructive method.

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