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Research and Analysis of Non-destructive Detection of Heroin Hidden in Human Body

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Abstract

In order to rapid, accurate and non-destructive identification in parcels in the digestive system of human body, the heroin, simulated skin and heroin covered by simulated skin have been investigated using energy dispersive X-ray diffraction (EDXRD) at different scattering angles and detection time, respectively. The respective diffraction profiles are obtained. The aim is to find out the optimum detection degrees and the shortest detection time to identify the heroin from simulated skin, and to provide the experimental basis for further identification in parcels in the digestive system of human body. The curves measured under different test time are analyzed by statistical method. The results indicate that the heroin can been confirmed at 14° scattering angle within one minute.

Key words Energy dispersive X-ray coherent scattering, non-destructive identification, heroin covered by simulated skin, statistical method.

1. Introduction

Drug has been a puzzling problem in worldwide. Drug smuggling is increasingly rampant, and criminals' drug trafficking means is cunning and changeable, a major one being the concealed in parcels. There are strict organization and definite division in drug trafficking group. Presently, drugs are transported through a variety of routes. Especially, it has been an important carrying method for drug trafficking group to hide drug in human body across the border. This method has already been the important smuggling means characterized with small-lot and intensiveness, including swallow drug and stuff drug through anus or vagina [1].It is of high concealment, furthermore it is difficulty to find and seize. Therefore, instant and accurate detection of hidden drug in high-speed flow of crowd and cargo has already become an urgently science and technological problem related to national security.

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At present, there are many drug detection methods and means, such as X-ray perspective detection, digital X-ray imaging technology, dual-energy (more energy) X-ray technology, neutron analytical techniques, associated particle imaging and biological detection, which are traditional method non-destructive. X-ray inspection apparatus are prohibited to inspect the human body because high doses of X-ray are harmful to human. The false positive rate of the last there methods are high because the drugs, explosives components, and some organic ingredients are very close [2-4]. At the moment, few of literatures related to detecting and identifying drugs hidden in the body or covered by simulated skin by EDXRD are been reported.

As a method of X-ray inspection, energy-dispersive X-ray diffraction (EDXRD) has been used for many years to measure the atomic planar spacing in a crystalline substance. In order to detect the body, the time taken to collect and analyse the diffraction spectra must be minimized. On one hand, the different spectral lines of energy spectrum and diffraction profiles are simultaneously recorded, on the other hand, radiated X-ray beam from the sample to the detector is poly-energetic, without any filter and processing, thus maintaining the original strength. As a result, the time to record the spectrum and diffraction pattern using energy dispersive spectrometer will be very short. Moreover, the data collection time can be reduced by optimizing the geometry of the system to collect as many scattered photons as possible whilst maintaining a sufficiently high momentum transfer resolution to allow the profiles from different substances to be clearly identified. The X-ray scattering spectra from drugs in their respective characteristics can be found in the diffraction peak which is regarded as their "fingerprints". By comparing diffraction profiles of the drugs and body, one can confirm whether drugs are present in the body or not. So, EDXRD is proposed as a suitable non-destructive method to rapidly identify drugs in body.

Whether can EDXRD be used to inspect the drugs hidden in the human body? What are the optimum detection parameters? And what effect of human skin will cause in detection process? In this article, an account will be presented of the application of EDXRD to detect heroin, simulated skin and heroin covered by simulated skin at different angles and detection time. The aim is to find out the optimum detection degrees and the shortest detection time to identify the heroin from simulated skin, and to provide the experimental basis for further identification in parcels in the digestive system of human body. It can also provide the database for development alarm system of fast, accurate and automatic detection heroin hidden in the human body.

2. Theory and method

The principle of operation is to irradiate the sample using a pencil beam of polychromatic X-rays and to measure the X-ray photons scattered under a fixed angle, allows the detection of several peaks which is differentiated by their specific energy and corresponding d-spacing within the material. In EDXRD, a polychromatic X-ray source is used and the diffraction profile is measured using an energy resolving detector [5].

The corresponding diffraction features appear at discrete angular values, as defined by the Bragg relation:

$$d = \frac{hc}{2E\sin(\frac{\theta}{2})}, \tag{1}$$

Where d is the spacing, c is the speed of light, θ is the scattering angle and E is the energy of diffraction peak.

When the scattering angle is fixed, corresponding d-spacing can be calculated according to the spectral lines of energy in the diffraction peak. Thereby, we can confirm the crystal structure and chemical structure of sample.

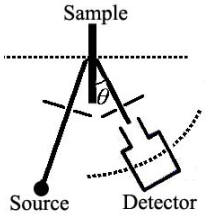

Fig.1. Schematic illustration of the EDXRD experimental arrangement

The experimental arrangement is shown in Fig. 1. For the present experiments, a polyenergetic X-ray spectrum was generated using a tungsten target industrial X-ray tube with 2mm diameter focal spot operated at 40 keV and an