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# The influence of X-ray wavelength and the simulative human skin and muscle obstruction on the detection of human body-hidden drugs by non-intrusive X-ray diffraction method

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**Abstract**

In order to detect the body-hidden drugs non-intrusively and rapidly, the influence of the X-ray wavelength and covering of the simulative skin and muscle on the detection of methamphetamine sample by synchrotron radiation X-ray diffraction (SR-XRD) technique have been investigated. Synchrotron radiation based X-ray with three different wavelengths (1.29Å, 1.54 Å, 1.80Å) has been chosen as the X-ray source. The results indicate that the intensities as well as the number of the diffraction peaks of methamphetamine sample covered by simulative muscle decreased with the increasing of the X-ray wavelength from 1.29Å to 1.80Å. In addition, the intensities of the diffraction peaks for methamphetamine will be seriously affected by the covered simulative skin or muscle due to the X-ray absorption. Furthermore, the absorption of X-ray by the simulative muscle seems much stronger than that of the simulative skin. Moreover, the specific molecular structure of the methamphetamine sample has been obtained by X-ray diffraction method.



*Keywords:* drug detection; SR-XRD; methamphetamine; molecular structure.

## 1. Introduction

Methamphetamine, also known as the drug “ice,” is one of the most widely consumed illicit drugs in the world today. The diffusion of methamphetamine and related ‘‘de-signer drugs’’ is dramatically increasing on the European illegal market. This trend is confirmed by the European Monitoring Centre for Drugs and Drug Addiction(EMCD-DA), indicating these kinds of drugs are widely spreaded in Europe as cannabis [1]. The National Drug Intelligence Center also reports that (t)- methamphetamine (METH) is the second major drug threat to the United States, only behind cocaine[2]. Furthermore, drug abuse is always associated with crimes, trafficking and mob, which generate

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many social issues. Obviously, for security reasons, practical detection technologies are aspired for the non-destructive and fast detection for those human body-hidden drugs.

Currently, different detection techniques for illicit drugs have been developed, such as acoustic detector technology [3], neutron/gamma-ray scattering analysis[4-6], and different X-ray inspection techniques including X-ray dual-energy transmission and scatter technologies [7,8] and energy dispersive X-ray diffraction method （EDXRD）[9-12].Among them, EDXRD method has been considered to be the suitable non-destructive method to rapidly identify different illegal materials, which can satisfy the above security requests. The details of the EDXRD have been reported otherwise [13]. For the application of EDXRD to detect body-hidden drugs, the influence of X-ray wavelength, the human skin, muscle and bone structures should be considered. However in the EDXRD method, normally an X-ray source with continues wavelength X-ray is adopted, so the X-ray with definite wavelength can only be emitted or removed simultaneously, which could not be used to investigate the influence of the wavelength of the X-ray. Synchrotron radiation (SR) X-rays have the advantages of tunable wavelength combined with the related monochromic beamlines, which can be used as ideal light source to investigate the influence of the wavelength of the X-ray in the EDXRD method.

In this study, the influence of the X-ray wavelength on detection of human body-hidden drugs was investigated. Then the effects of the covering skin or muscle on the methamphetamine sample have been systematically simulated. Moreover, the molecular structure of the methamphetamine sample has been investigated based on the experiments of SR-XRD.

## 2. Experiment

The experiments in this paper have been carried out at the X-ray diffraction and scattering station in the National Synchrotron Radiation Lab of University of Science and Technology of China. The X-ray diffraction and scattering station has a commercial imaging plate detector system (Mar345), which contains an imaging plate of diameter 345mm and a program selectable pixel size 100 or 150 mm with a maximum readout time of 88s. This station is also equipped with a Huber Ψ diffractometer, which is useful for the general purpose of X-ray diffraction works, including high-resolution diffraction (single-crystal or powder samples), multiple beam diffraction and some surface diffraction [14]. In the current study, the Mar 345 commercial imaging plate detector was used as the detector as shown in Fig.1.

The methamphetamine sample used in the experiments is applied from the first research institute of ministry of public security of the People's Republic of China.

In the experiments, the artificial simulative skin and muscle were used to substitute the true human skin and muscle. The densities, structures and elements of the simulative skin and muscle are similar to true human skin and muscle.

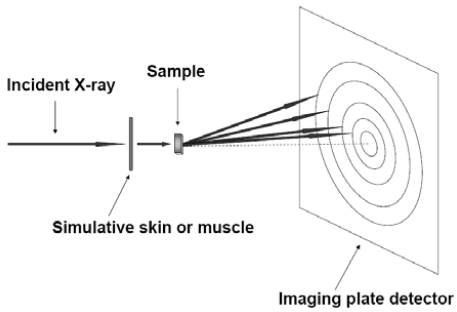


**Fig.1 Schematic representation of SR-XRD**