



B131 Application of Synchrotron Radiation X-Ray Fluorescence to the Analysis of Forensic Trace Evidence

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This presentation will define the application of synchrotron radiation X-Ray fluorescence (SR-XRF) to the analysis of forensic trace evidence.

When trace physical evidence, such as glass fragments or rust of iron, is encountered at an actual crime scene, it should be compared with the same kind of material collected around a suspect in order to prove the relationship between the suspect and the crime and/or victim. Elemental analysis of physical evidence has been performed by ICP-AES, ICP-MS, SEM/EDX, or XRF at forensic laboratories. However, ICP-AES, and ICP-MS require destruction of samples and time-consuming pre-treatment, as well as large amount of samples. Scanning electron microscope equipped with energy dispersive X-Ray analyzer and XRF method does not show enough sensitivity for analysis of trace elements. Synchrotron radiation X-Ray fluorescence spectrometry has potential to the nondestructive analysis of trace elements with the extremely high efficiency. In this study, the importance of trace elements analysis using SR-XRF was evaluated in the forensic discrimination of trace physical evidence by the comparison of trace elements.

In this experiment, arsenous acid (As_2O_3), headlight glass, and rust of iron were selected. Thirteen kinds of commercially available As_2O_3 were collected. Of the samples, 7 were manufactured in Japan, 4 in China, and 1 each in Germany and Switzerland. Glass fragments were taken from the headlights of 17 different cars. The rust samples were prepared by immersing NIST (National Institute of Science and Technology) standard reference materials in the purified water for 1-2 days. The rusty chips were transferred to the filter paper. After drying, the filter paper was cut into 5mm x 5mm and applied to analysis by SR-XRF.

All the measurements using SR-XRF were carried out at BL08W beam line of Spring-8. A small sample was placed on the sample holder with the adhesive tape or the polypropylene sheet. This holder was set on the automatic X-Y stage and irradiated by monochromatic X-Ray, 116 keV, which could excite K-shells of all the elements. The X-Ray beam size was adjusted to 1.0mm x 0.8mm for the As_2O_3 and the headlight glass, and 0.5mm x 0.4mm for the rust. X-Ray fluorescence spectra were obtained by an energy-dispersive XRF analysis system composed of a pure-Ge solid-state detector.

Analytical results obtained for each material were as follows.

1) Arsenous acid samples exhibited the characteristic patterns of trace elements in countries where the samples were manufactured countries and could be classified into the 3 categories. Various kinds of elements, such as Sn, Sb, and Bi, were found in Chinese samples; whereas, only Sb was characteristically found in Japanese samples; and, no trace elements could be detected from the samples from Germany and Switzerland. K-line of As normalized the peak intensity of each trace element and this parameter was compared with the concentration determined by ICP-AES. Sufficient correlation values were observed between these two methods.

2) Trace impurities, such as Zn, As, Sr, Zr, Sb, Ba, and Hf could be analyzed using a single fragment of sub-mg level. Most pairs of samples with identical refractive index (RI) value could be distinguished from each other by the comparison of SR-XRF spectra. Of 136 pairs among 17 samples, 135 could be discriminated by the combination of RI measurement and SR-XRF analysis, while 19 pairs could not be discriminated by the RI only.

3) In addition to dominant K-line of Fe, which appeared in the spectrum of all the rust samples, the peak of trace elements with certified values, such as Mo and W, was observed in some of the rust samples. This result suggested that SR-XRF spectra of the rust sample reflected to the components of the original materials. But the conventional analytical instruments, such as microprobe X-Ray fluorescence and ICP-AES spectrometers, could not measure these trace elements in the rust samples.

In conclusion SR-XRF has great potential for the nondestructive analysis of ultra trace physical evidence with extremely high sensitivity.

SR-XRF, Trace Evidence, Trace Element