Micro-XRF analysis for lead contamination in toys

Introduction

Environmental issues are becoming increasingly important, and regulatory bodies across the world are beginning to impose strict guidelines affecting manufacturers and importers for a very wide range of products. The European WEEE/RoHS regulations are just one example, where each and every component in almost all electrical equipment must have levels of lead, cadmium, mercury, hexavalent chromium and certain brominated polymers below fixed levels. More recently, there have been growing concerns over the presence of harmful materials within toys.

Figure 1: High lead content in imported toys can cause serious illness

To a child a toy is an object which could be held for extended periods, put in the mouth, and even swallowed (albeit unintentionally). Hence it is paramount that toys are made with materials which present no health risk. The number of product recalls for such health and safety reasons has doubled in the last five years, which is perhaps an indication of increasing pressure for low cost manufacture with less emphasis on quality/safety. In 2007 alone, many millions of toys in the USA were recalled on account of high levels of lead – usually caused by lead based paints. Lead can cause a number of serious health problems, including learning disabilities, kidney failure, anaemia and even irreversible brain damage. Thus, it is vital for manufacturers, importers and government laboratories to have fast, reliable tests for such materials.

Micro-XRF for regulatory analyses

X-ray fluorescence micro-analysis provides just such a solution. Within a typical analysis time of 30s it is possible to quickly ascertain not only what elements are present (ranging from sodium to uranium), but also their concentrations (at % and ppm levels). The XGT series of micro-XRF instruments can be equipped with multiple beams of different sizes. Ranging from 1.2 mm down to a world leading 10 µm these ensure that different sized components/features can be accurately and discretely analysed. This is particularly important for quantitative measurements.

Quantitative calculations and calibrations are based on the assumption that all of the x-rays are incident on and absorbed by the sample. If the component is smaller than the x-ray beam, then this assumption is no longer valid, and incorrect results will be obtained. Importantly, these will be false negatives, allowing potentially dangerous toys to go onto the market.

In this application note, results obtained on an XGT micro-XRF system are discussed, showing how XRF spot analysis and imaging are used in this safety campaign.

Results

A suspect toy (Figure 2) was analysed for elemental composition in a number of regions. Whilst most points revealed zero or negligible concentrations of lead, there was one area which gave significant cause for concern. By partially dismantling the toy it was possible to more fully interrogate this concern area.

Figure 2: the toy used for analysis, showing the specific region of concern before and after partial dismantling.

The toy, a plastic robot-machine with movable limbs and weapons, includes caterpillar tracks composed of a black polymeric material. Spot analysis (Figure 3) on the left hand track shows a very low concentration of lead (52 ppm), which is well within the limit of 600 ppm suggested by the USA's Consumer Product Safety Commission (CPSC). However, the other track reveals a lead content of 3000 ppm, which would present a serious health threat to a child.

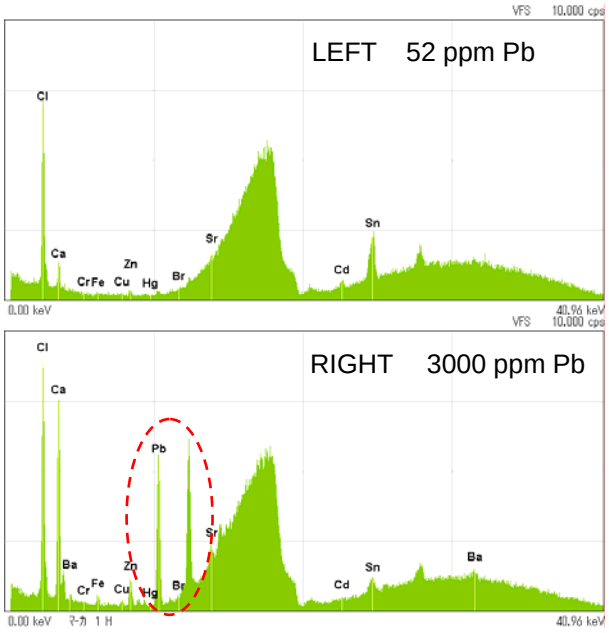

Figure 3: XRF spectra acquired from the left and right caterpillar tracks.

A low resolution XRF image (Figure 4) acquired over the caterpillar tracks clearly illustrates the difference in composition of the two tracks – the one on the left shows negligible lead content, whilst the right hand track has a uniformly high lead content.

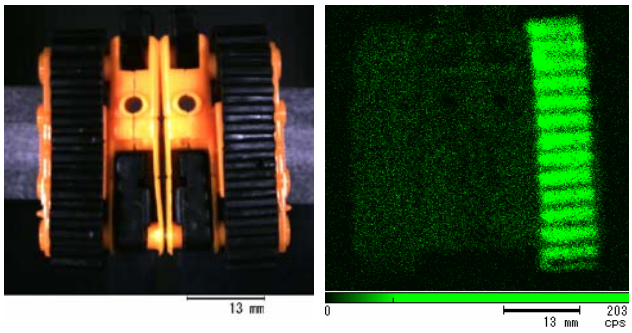

Figure 4: Optical image (left) and low resolution XRF image (right) showing the distribution of lead in the caterpillar tracks.

Summary

The XGT series of micro-XRF analysers provide a platform for fast and simple analysis of harmful elements within toys and other consumer goods. Spot measurements with a variety of x-ray beam diameters allows both macro and micro analysis – the latter is particularly important to obtain correct quantitative data from very small components and features on the toy. An example toy has been analysed, and high concentrations of lead have been observed in certain regions. XRF imaging allows large areas to be quickly analysed for element distribution, clearly high lead regions with high lead content.

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