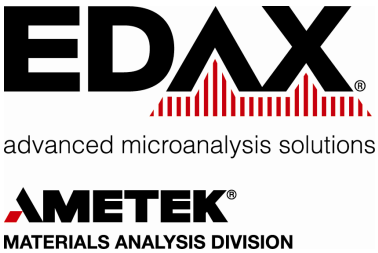
Application Note: XRF

The *Orbis* micro-XRF Analyzer for RoHS and WEEE Compliance Testing



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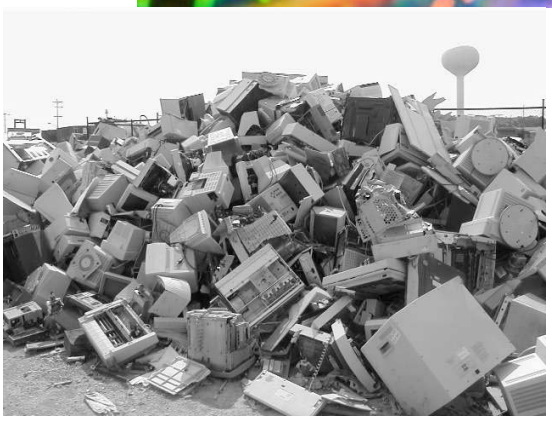
Introduction:

Government legislation is targeting materials in consumer products which become hazardous wastes upon disposal of the product. Currently, the most prominent legislation is the European Union's directives on the ***R***estriction ***o***f the use of certain ***H***azardous ***S***ubstances (RoHS – EU directive 2002/95/EC) in electrical and electronic equipment and **W**aste **E**lectrical and **E**lectronic **E**quipment (WEEE – EU directive 2002/96/EC). The EU's RoHS directive sets limits on the use of Cd, Pb, Hg, Cr{6+} and Br (used in PBB and PBDE fire retardants) in electrical and electronic equipment, e.g. personal computers, cell phones and electronic toys. The RoHS limits set are < 100 PPM for Cd and < 1000 PPM for Pb, Hg, Cr{6+} and Br in each *homogeneous* component of the product, for example molded plastic components, plastic cable insulation and solder joints on a printed circuit board (PCB). WEEE requires manufacturers to provide for collection, recycling and disposal with an emphasis on recycling and reuse of their old equipment or equipment components. Manufacturers wanting to export products to markets covered by this type of legislation will have to confirm that their products comply with these regulations by monitoring their products for restricted materials. Within the EU, each EU country will be responsible for establishing a program for RoHS compliance enforcement on imported products. In the future, similar legislation is expected in other parts of the world.

Orbis micro-XRF:

Energy Dispersive XRF, being non-destructive and requiring minimal sample preparation, is a well-suited elemental analysis technique for RoHS compliance testing and is capable of achieving the necessary detection limits. For RoHS compliance testing, XRF is capable of screening and quantifying for Cd, Pb and Hg. However, EDXRF, being an elemental analysis spectroscopy, cannot be used to distinguish between Cr{6+} and Br in PBB and PBDE flame retardants, which are restricted, and other forms of Cr and Br, which may not be restricted. Hence, for Cr and Br, EDXRF is suitable as an initial screening method. The Orbis micro-XRF elemental analyzer has additional advantages for RoHS compliance testing including:

- Small sample analysis
- Localized analysis on larger samples (e.g. PCB's) selected via the sample's video image
- Elemental mapping
- Primary beam filters for improved detection limits on a variety of samples



Example 1: Cadmium in Plastics:

Plastics often contain a variety of additives to improve the characteristics or appearance of the material. The use of cadmium is being restricted in many applications due to its toxicity. The Orbis is capable of measuring cadmium in plastics to a detection limit, i.e. MDL(2σ) ~ 10 PPM, one order of magnitude less than the RoHS limit on cadmium. Analysis of a series of standards for cadmium in polyethylene is shown in Figures 1 and 2.

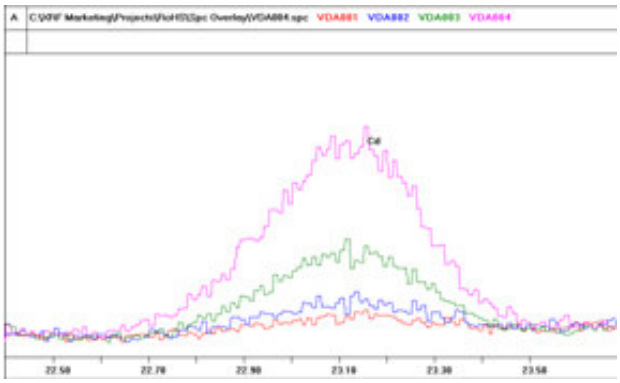


Figure 1: Cd(K) peak in a suite of polyethylene standards

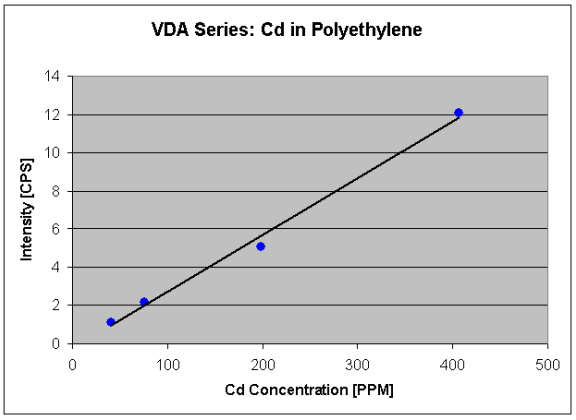


Figure 2: Plot of Cd(K) intensity versus Cd concentration showing a linear relationship

Example 2: PCB Analysis:

The RoHS directive, as with any governmental legislation, is somewhat complicated in that there are a variety of exemptions where the restricted materials may be used. Generally, under the RoHS directive, standard 60-40 SnPb solders are no longer allowed. However, there are some exemptions for the use of Pb within an electronic device itself where technical alternatives are not available.

An electronic toy manufacturer approached EDAX with a difficult problem concerning their populated PCB's. The manufacturer could monitor and restrict the use of banned materials, for example Pb solder, during the PCB assembly process simply by monitoring the solder. However, after the PCB was assembled and if the PCB failed, repairs were necessary. Repairs were done at another facility within the manufacturing company or by a 3rd party contractor. XRF analysis of the repaired PCBs using large spot, lab-based or handheld XRF instruments were indicating Pb, while the repair facility and the 3rd party contractor claimed that only Pb-free solder was used to make repairs. The Orbis was used to rapidly image the repaired area of a suspect PCB to determine the source of the Pb signal. The elemental maps are shown in Figures 3(a)-(d).

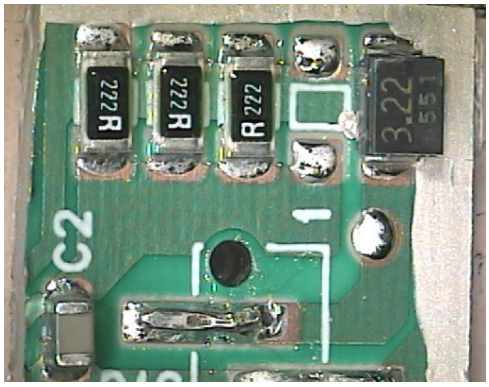


Figure 3(a): PCB video image

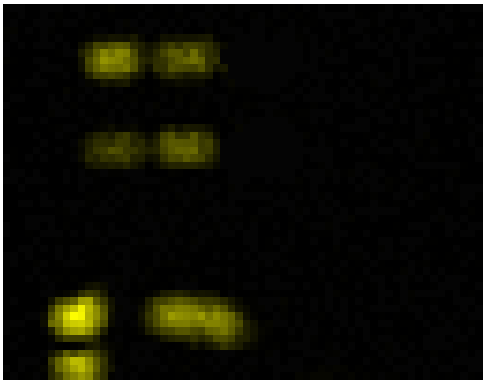


Figure 3(b): Ni elemental map

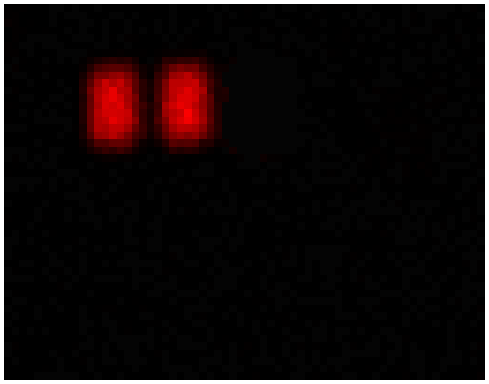


Figure 3(c): Pb elemental map

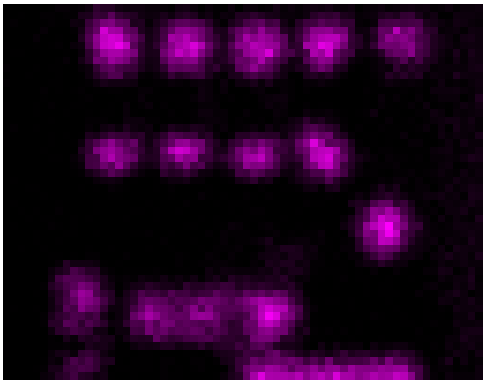


Figure 3(d): Sn elemental map

The solder contacts on the PCB show up only in the Sn and Ni maps which supports the claims of the party's responsible for repairs that only Pb-free solder was used. The Pb map shows that the Pb originates from 2 of the 3 chip components mounted approximately in the upper left quadrant of the map. Review of the bill of materials for the board and a further explanation from the design engineer clarified that Pb was used within the electronic device itself. The manufacturer's regulatory office had determined

that the use of Pb in this way was considered exempt from the RoHS regulations. Hence, the source of Pb on the PCB could only be resolved by a small-spot XRF system like the Orbis.

Summary:

The Orbis micro-XRF analyzer is capable of screening and quantifying toxic materials covered by environmental legislation, e.g. the RoHS directive for Cd, Pb, Hg, Cr and Br and the WEEE directive. Plastic materials can be screened for common additives such as Cd and Pb. Assembled components can be screened and imaged to pinpoint the source of toxic materials to distinguish between restricted uses and legitimate, exempted applications avoiding the possibility of further costly, destructive analysis or delays at customs facilities. Given the non-destructive nature of the XRF method and the compactness of this tabletop unit, the Orbis is ideal for environmental compliance screening in the laboratory or at a customs facility.