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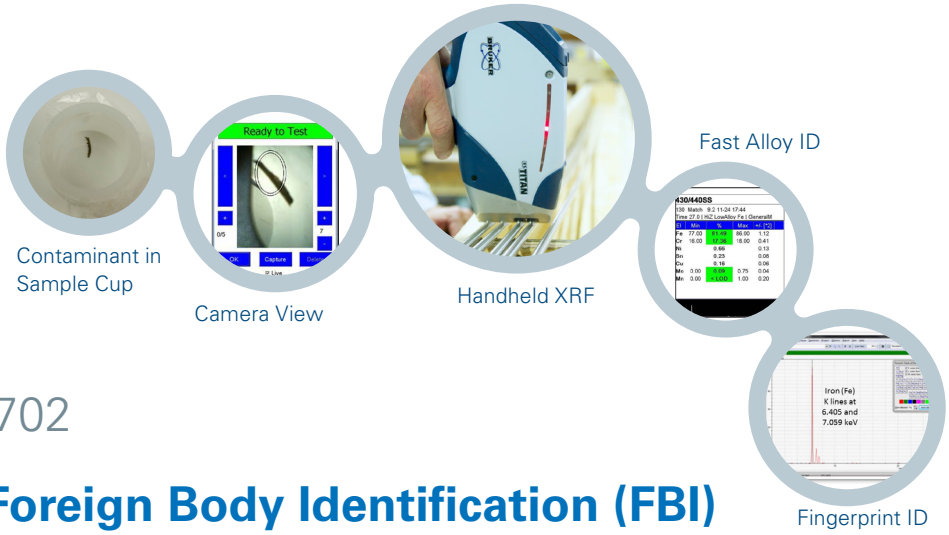


Application Note #1702

Fast and Efficient Foreign Body Identification (FBI) in Food Product Manufacturing with HH-XRF

Nobody wants contaminants in their final products, but it can happen to any manufacturer. Handheld XRF analyzers help production, maintenance and QA/QC quickly determine the composition of any foreign body; and, when an integrated audit library of production floor equipment is available, they help identify the source of the contaminant quickly and efficiently.

Portable XRF analyzers have long been used to identify metals, alloys, plastics, other materials and even unknown substances when simple, fast and accurate testing is needed. Handheld XRFs provide the additional benefit of being agile enough to take onto the manufacturing floor for in-service equipment testing or to the stock room for incoming and inventoried materials.

How Handheld XRF ID's Material

The technology behind handheld XRF is X-ray fluorescence (XRF). In a way, it's like using a high powered flashlight which sees beyond what we humans can. When the light source is turned on and touched to a material, it 'sees' the energy of the elements in the periodic table, anywhere from magnesium (Mg) to uranium (U).

It is a non-destructive tool and 'senses' how much of those elements are present in the material. For instance, if it's touched to a sterling silver coin, it will see the elements, silver (Ag) and most likely copper (Cu). Along with reporting their presence, it will show the composition as 92.5% Ag and 7.5% Cu.

Libraries of common alloys are stored in Bruker's handheld XRFs; and, they can actually report the common name of the alloy on the screen. If it is touched to a piece of 304 Stainless Steel, it will see iron (Fe), chromium (Cr), nickel (Ni), manganese (Mn) and other lower concentration elements identified as 304SS.
Additionally, it will report the concentrations it 'sees', the minimum and maximum amounts found in that alloy grade, the precision of the results, as well as the date and time of the test. This all happens in seconds.

Bruker S1 TITAN handheld XRF screen showing 2 second results of 304SS identification test

So, how does this work for foreign body identification in a food production facility? When a contaminant is discovered, it can be tested quickly with the handheld XRF. If it's a large piece, the nose of the XRF is touched to the sample, the test is started and the alloy is identified.

However, contaminants are frequently quite small, not large pieces. The most convenient way to use the handheld XRF for small samples is in its desktop configuration. The procedure to test an unknown small piece is straightforward.

TRACER 5i HH-XRF in a desktop stand. Samples as small and fragile as slivers are typically placed on the plastic wrap of sample cups. Prior to running the test, the analyzer head and sample are covered.

Cataloging Production Floor Alloys with HH-XRF

Bruker handheld XRFs already contain alloy libraries for identification, but in order to determine the source of a contaminant, an XRF audit of all equipment on the production floor must be performed. Once this information is stored, a production floor matching catalog exists in the handheld XRF which contains each piece of equipment or component's metal or alloy grade, as well as their elemental concentrations.

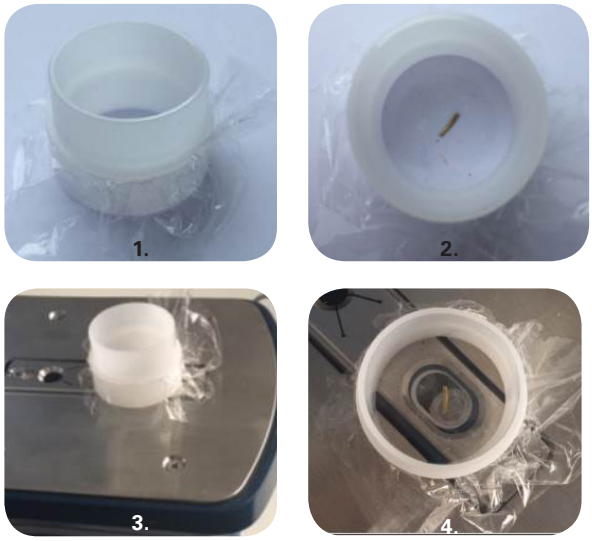
It's recommended to begin by developing a catalog of all likely metal surfaces that come in contact with food and have a potential for breaking. A simple 30 second test of likely culprits such as food augers, roller mills, air locks and drying conveyors made of metal webbing would be a good place to start. All of the testing conditions and results are stored in the handheld XRF and can be transfered to a PC.

In summary, if a metal sliver contaminant is identified as 430/440SS, then the information in the catalog would indicate which piece of equipment, component or tool the contaminant came from. This information helps plant management take corrective action on that piece of equipment in a timely manner.

Small Piece Foreign Body Identification Test

Best practice procedure for handheld XRF to test small samples:

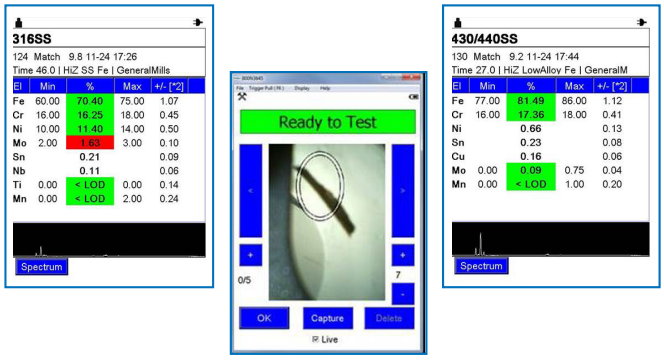
1. Prepare the sample using a thin Prolene® or Ultralene™ XRF film.
2. Place contaminant sample on a sample cup.
3. Place sample cup on the desktop stand.
4. Position the cup with sample at the center of the XRF window.



Alloy Library Identification of Contaminant

Streamline the amount of time it takes to identify the source of a contaminant on the production floor by auditing, cataloging and testing all production floor equipment first.

1. Audit all equipment, components and tools on the production floor with the handheld XRF to create a catalog of potential sources of contaminants.
2. If a contaminant is found, test it with the handheld XRF.
3. Identify the contaminant by matching its alloy identification with the production floor audit catalog.



Handheld XRF technology helps save time and costs for foreign body identification. It is non-destructive and provides actionable information.

Identifying Spectral Fingerprints with Handheld XRF

The basic steps in testing with a Bruker handheld XRF include calling up the "application", such as Alloys; setting the desired duration of the test; and pressing the start trigger. Data collected include not only the alloy or metal name and elemental concentrations, but also a spectral fingerprint. It is seen at the bottom of the measurement results screen. It also can be viewed on a full-size SPECTRUM screen.

The spectral fingerprint is very important for FBI work because much of the equipment and components in food processing use the same types of alloys. However, even the same alloy used in different parts has different characteristics which can be identified through a catalog of fingerprints.

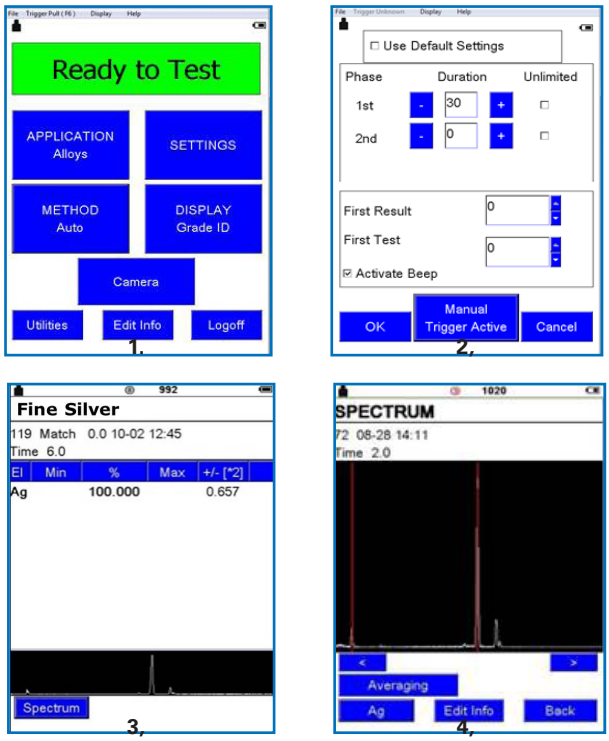
The "eyes" of the XRF, or its detector, recognize an element by the energies it gives off after the trigger is pressed. These energy patterns are unique to each element; and, they can be comprised of one or more levels. The most common energy levels the handheld XRF can see are what are referred to as the K and L lines; sometimes M lines can also be seen. The energies at which these lines (or peaks)

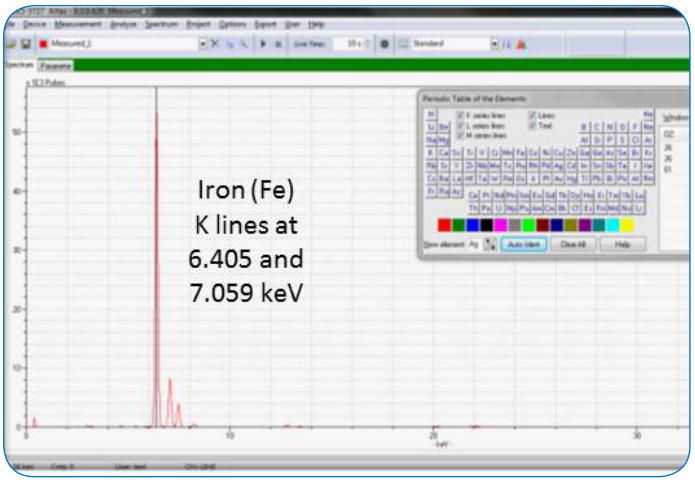
Bruker's handheld XRF PC software programs enable additional features, such as remote control and viewing, as well as the comprehensive data analysis software, ARTAX™.

Handheld XRF Basic Testing Steps

After the handheld XRF is turned on, it leads you through the testing sequence.

1. In the **Ready to Test** screen, select the APPLICATION.
2. In the SETTINGS screen, input the duration of the test. Press the trigger on the handheld XRF to start the test.
3. View results on the screen which include identification of the material, the elements in the material, their concentrations, the accuracy of the results and its spectral fingerprint.
4. View enhanced display of material's spectral fingerprint.

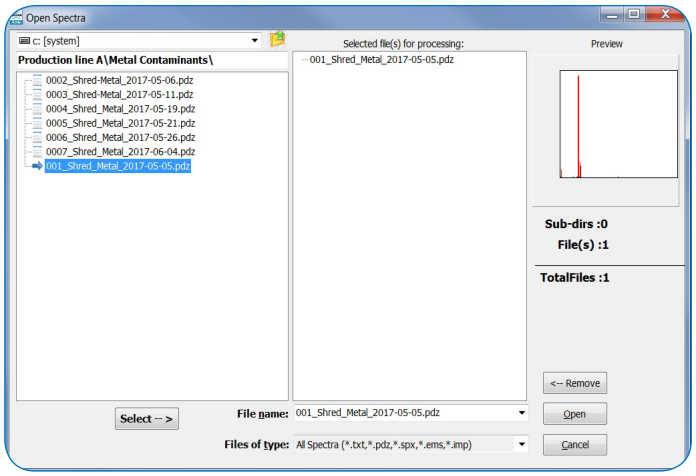




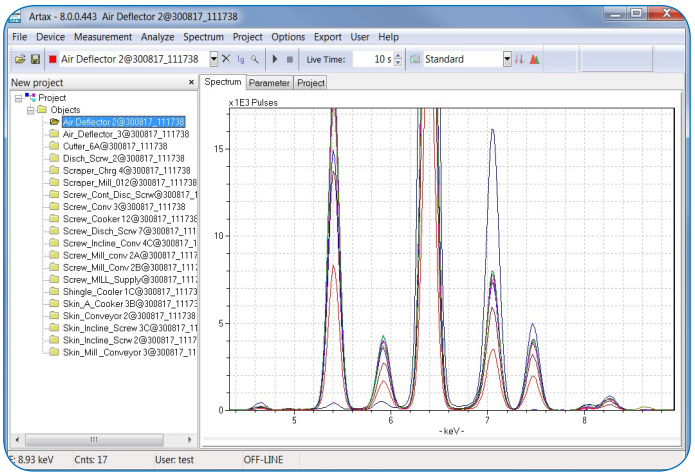
Spectral Fingerprint: The energies at which the K, L or M lines appear identify which element(s) the XRF sees. The XRF sees iron's (Fe) K lines above. The height, or intensity, of each line (or peak) helps determine the quantity of the element(s) in the sample.

Matching Spectral Fingerprints with ARTAX™ PC Software

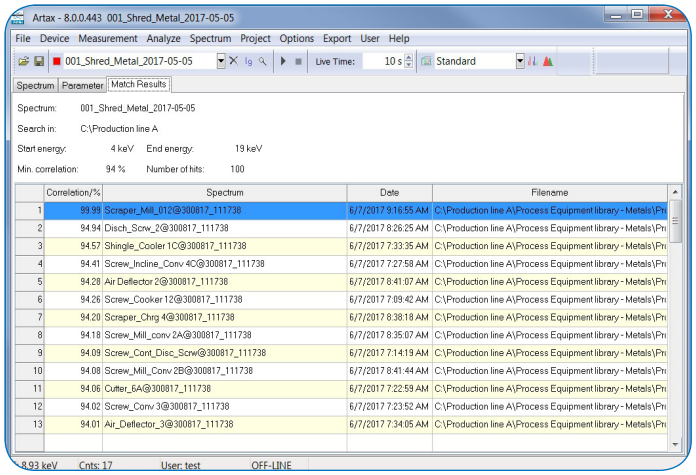
For metal contaminant spectral fingerprint matching, the fingerprints of all the metal/alloy components, including screws, air deflectors, skins, etc., used in a given production line are placed in a folder named accordingly. Similarly, fingerprints of contaminants, such as a piece of shred metal, are named and placed in a contaminant folder. Spectrum Match in ARTAX™ software is then used to identify the contaminant's source by matching its spectral fingerprint with those in the catalog.



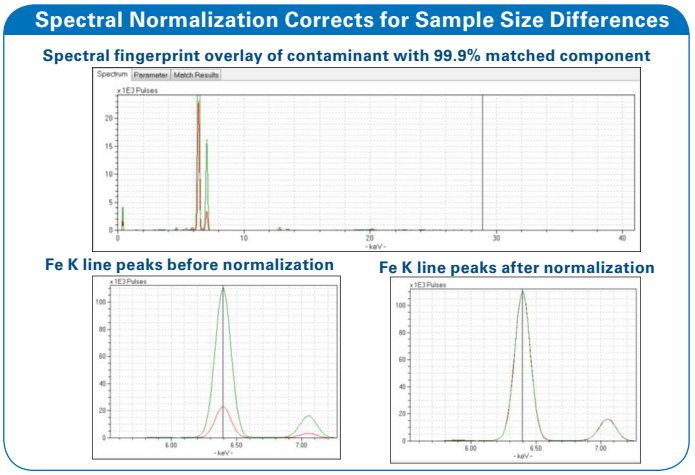
A contaminant spectral fingerprint, such as 01_Shred Metal, is transferred from the instrument to a relevant folder, such as Metal Contaminants.



Cataloged spectral fingerprints from the Production Line folder containing relevant process equipment is opened to compare the contaminant.



Spectrum Match function identifies which spectral fingerprint in the catalog is the closest match to the contaminant, providing a % probability.



Highest probability spectra is overlaid with the contaminant's to confirm. **Normalization** corrects intensity differences due to sample size differences.

Summary

Handheld XRF provides food product manufacturing plants with a fast and efficient foreign body identification (FBI) tool. It can be used to identify materials including metals, alloys and plastics. The equipment and components on a given production floor are first tested with an XRF and collected in a catalog. When a foreign body is discovered, the portable XRF can identify its composition. The source of the foreign body can then be determined either by matching criteria on the handheld XRF testing screen, such as alloy grades, or by spectral fingerprint matching using ARTAX™ PC software. Information from Bruker's handheld XRF analyzers helps plant management to take corrective action on defective equipment in a timely and cost-effective manner.

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