LIBS versus X-ray spectroscopy

Lyndon Momberg, SciAps Product Specialist for the NDT equipment specialist, Gammatec, talks about modern spectroscopes for analysing the concentrations of different elements in various metal alloys. He compares laser-based (LIBS) and X-ray based systems and highlights the advantages of each.

LIBS is an acronym for Laser Induced Breakdown Spectroscopy. These handheld analysers use a high-focused laser to ablate the surface of a sample. This results in a plasma being formed that consists of electronically excited atoms and ions. As these highly excited atoms 'decay' back into their ground states, they emit characteristic wavelengths on the electromagnetic spectrum that relate directly to the composition of the alloy being tested.

This makes handheld LIBS analysis an excellent tool for quickly and easily identifying the exact composition or grade of a metal alloy.

X-ray spectroscopy or X-ray fluorescence spectroscopy uses X-rays to excite the surface of the metal being tested. These excite the atoms of the material, causing high-energy photons to be emitted from each element. By analysing the energy associated with each of the emitted photos, individual elements and their percentage composition can be identified.

The analysis techniques have different strengths and weaknesses when it comes to individual alloying elements, so for best results it becomes important to use the most suitable type of analyser for the specific alloy of interest.

Testing aluminium

Historically X-ray has performed poorly on aluminium alloys. However, the SciAps X-250 features an advanced X-ray tube technology and an aluminium analysis algorithm that can separate 90% of all aluminium alloys within 2.0 seconds and identify the remaining 10% within 4.0 seconds.

In addition, the focus has been put where it needs to be: magnesium (Mg) and silicon (Si) analysis.

With respect to lithium (Li) however, LIBS analysers can measure lithium concentrations, but X-ray systems cannot. Also, nearly every aluminium alloy with lithium also contains silver (Ag), which is added together with the lithium. X-ray analysers can all measure silver, which can be used as an indicator for lithium in lithium-containing aluminium alloys. If you see Ag in aluminium, it is highly likely that Li is there as well.

Analysis of red metals

LIBS can measure aluminium and silicon content and silicon bronzes in a single fast test. The SciAps X-250 can now measure typical levels of silicon and aluminium in bronzes in 1 to 2 seconds. Testing time is therefore 3 to 4 seconds if the silicon and aluminium concentrations are included, and 1 to 2 seconds if excluded. The X-250 software automatically determines if the material is an aluminium or silicon bronze and extends the test. The X-250 performs the most efficient test.

What about beryllium? The SciAps LIBS analyser can measure beryllium in a red metal, while X-ray-based systems cannot. Cobalt, however, is an indicator element for beryllium in copper alloys. If cobalt is measured in a copper alloy, beryllium will be present as well – and cobalt is easily measured using X-ray analysis.

If using cobalt as an indicator for beryllium copper alloys, then the X-250 is a better choice for general red metal sorting. If measuring beryllium in the copper alloys; lithium in aluminium alloys; boron in nickel, stainless or ferrous alloys; or carbon in anything, however, then the SciAps LIBS systems are the better choice.

Options for ferrous and stainless steels

Material processors and fabricators dealing with steels tend to use LIBS analysers to sort carbon steels by carbon content, a great application for the argon-purged SciAps Z 200 C+ LIBS analyser, which is the only handheld analyser that can identify carbon content. LIBS analysers are also able to segregate cast and ductile irons by magnesium content, while X-ray systems cannot measure these low levels of magnesium.

In conclusion, the SciAps X-250 plus X-ray based analyser with the aluminium app will deliver exceptional performance on aluminium alloys. But for many specialty applications mentioned above, LIBS is an excellent alternative handheld technology.

Gammatec's view on the interplay between LIBS and X-ray is therefore easily stated: Use LIBS if you need one of the specialty applications described here. In all other cases, X-ray is the better option.

Or in a single line: use X-ray wherever possible, and LIBS if X-ray cannot do the job.

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