



900 Series

K shell range CI (17) to Ba (56) L shell range Cs (55) to U (92)



K shell range Ti (22) to Dy (66) NITON[®] Infiniton[™] L shell range Ho (67) to U (92) Half life: 432.2 years

NITON[®] XL3t[™] Light Matrix - Application-specific configuration only

How Does Portable XRF Work?

To understand how x-ray fluorescence works, a basic understanding of the structure of an atom is necessary. The nucleus of an atom is made up of both positively charged particles called protons and electrically neutral particles called neutrons. Orbiting around the nucleus are negatively charged electrons. Electrons can have different orbits, called shells, which are labeled sequentially starting with K, L, M, N, O, P, etc.

The electrons of the K shell are of the lowest energy; therefore, the bond to the nucleus is the greatest. The electrons of the L shell, M shell, etc. are of higher energy and are therefore not as tightly bound to the nucleus. When an outer shell electron jumps to an inner shell (e.g., an M or N shell electron jumps down to the L shell) less energy is required to maintain that lower energy



orbit, and thus the leftover energy is emitted by the atom as a characteristic x-ray. These are the x-rays that are analyzed by the detector within the XRF analyzer. Gamma rays or x-rays with sufficient energy can knock an atom's electrons out of orbit. This primary exciting radiation is generated within the instrument by an x-ray source, either an x-ray tube or radiation emitted by the natural decay of a radioactive isotope. The source in the instrument is positioned in such a way as to allow the exciting x-rays to fluoresce the sample, but not enter the detector.

When an electron is ejected from its shell, the vacant shell is usually filled by an electron from another shell in a step-wise fashion. For example, when a K shell electron is emitted, an L shell electron jumps into its place and creates a subsequent vacancy in the L shell. Similarly, the L shell vacancy is filled by an M shell electron, with the simultaneous emission of the characteristic L

x-ray of that element. This process continues to the outer shells in such a way that when K x-rays are generated, L, M, N (and so on) x-rays are also emitted. This cascading effort does not have to be initiated at the K shell. It can start at the L, M, or higher shells.



X-rays form part of the electromagnetic (EM) spectrum and have similarities to other forms

of EM radiation, such as infra-red and radio waves. Each element in the periodic table has a characteristic x-ray spectrum that is unique, rather like a fingerprint. These unique x-ray energies are measured with a high-resolution semiconductor detector which identifies the energy of the incoming signal (which identifies the element), and counts the number of signals occurring at that particular energy (which defines the concentration of the element within the sample). Since each energy represents the presence of a specific element such as chromium (Cr), iron (Fe) or nickel (Ni), the specific element and its percentage concentration within the sample can be calculated by the instrument's computer.

Once the computer has the elemental composition, it may be enhanced to reference an onboard library to give specific information about the sample, such as alloy grades. The information may also be stored for future reference including downloading.

The XRF Analysis Process in Brief



- 1. Primary x-ray energy is produced by the analyzer and directed at the sample surface.
- 2. The primary energy causes inner-shell electrons to be ejected from their orbits in individual atoms.
- Vacancies left by ejected electrons are filled by electrons from outer shells, resulting in emissions of fluorescent x-rays, each of which is characteristic of the element from which it is emitted.
- 4. The fluorescent x-rays enter the detector, which registers the individual x-ray events and sends electronic pulses to the preamp.
- 5. The preamp amplifies the signals and sends them on to the Digital Signal Processor (DSP).

- The DSP collects and digitizes the x-ray events occurring over time, and sends the resulting spectral data to the main CPU for processing.
- 7. The CPU, using various advanced spectral processing algorithms, mathematically analyzes the spectral data to produce a detailed composition analysis.

For metal alloy samples, the resulting data is then compared against an internal table or library of min/max specifications to determine an alloy grade or other designation for the tested material.

8. The composition data and any resulting identification is then simultaneously displayed on the instrument screen, and stored in memory for later recall and/or download to an external PC.

