

A photograph showing a large quantity of crushed aluminum cans in a recycling bin, illustrating the subject of the white paper.

Aluminum Recycling: Adding Value by Analysis

Mobile Spectrometers for Easy Analysis and Identification of Aluminum Alloys

Introduction

Recycling aluminum alloys provides both financial and environmental benefits that have led to the rise of a major global industry. Aluminum alloys are particularly amenable to recycling; they can be reprocessed many times without losing their useful properties. Also, recycling uses only 5% of the energy required to extract and refine new aluminum, so huge energy savings can be achieved.

Many specialized aluminum alloys have been developed for applications such as the aviation and automotive industries; these alloys command premium prices, both as new material and scrap. It is therefore important for the recycler to accurately identify incoming material, and to

separate different alloy grades before processing. This is best done by elemental analysis.

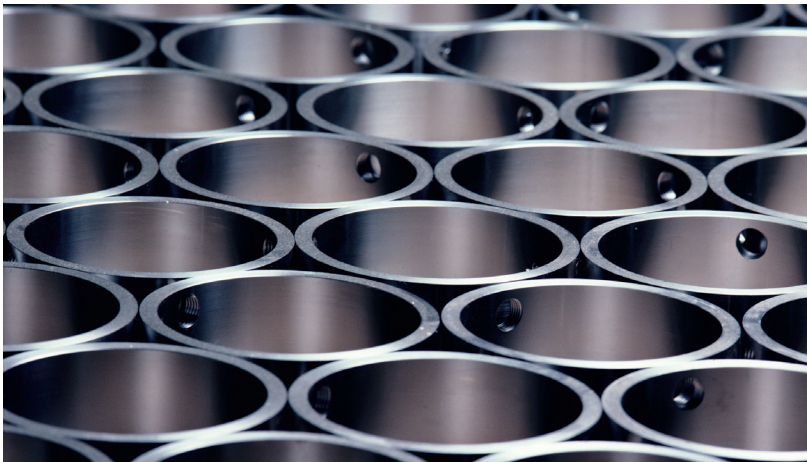
Laboratory-based elemental analysis is sometimes not feasible or necessary; can involve unacceptable delays; and is always expensive. Fortunately, modern mobile and portable analyzers are available that can handle the necessary analyses on site. They provide accurate, positive material identification, even when used by non-specialist operators. This paper describes two such instruments from SPECTRO Analytical Instruments — the SPECTRO xSORT handheld metals analyzer and the SPECTROTEST mobile emission spectrometer — and explains their application for the analysis of aluminum alloys.

Primary Aluminum

Aluminum (or aluminium; both names are accepted by IUPAC) is the most abundant metallic element in the earth's crust.

However, it was unknown in its metallic form until the early 19th century, due to the difficulty of extracting the metal from its ores. Most early extraction metallurgy (e.g., for iron) involved reduction of oxide ores with carbon, but this is not possible for aluminum because the element is a stronger reducing agent than carbon.

Today, virtually all primary aluminum production is by the electrolytic reduction of aluminum oxide Al_2O_3 , prepared from its principal ore: bauxite. Bauxite, an impure mineral typically containing less than 50% Al_2O_3 , is first separated from the mineral using hot sodium hydroxide extraction, followed by precipitation and subsequent calcination. The purified Al_2O_3 is then electrolyzed between graphite electrodes using molten synthetic cryolite (Na_3AlF_6) as a flux, and with AlF_3 added to lower the melting point of the mixture. Electrolysis is carried out at a temperature approaching 1000 °C, using currents of thousands of amperes.



Clearly, such a process is very capital-intensive and immensely expensive to run in terms of electrical power, which can represent up to 40% of the cost of the aluminum. Increasing costs of energy and environmental pressures on its consumption are major drivers for recycling aluminum and its alloys. The key fact: recycling demands only 5% of the energy required to produce primary aluminum.

Aluminum Alloys and Their Uses

Pure aluminum is relatively soft and mechanically weak, but in its pure form it does have good corrosion resistance, and its strength can be increased by mechanical processing such as cold-rolling. The real benefits appear in alloy forms. Alloying with metals such as copper, zinc, magnesium, manganese, silicon, and lithium can produce engineering materials that are very light — but display high tensile strength that may approach that of steel. This combination of properties has led to the very extensive use of aluminum alloys in aerospace and in the automotive industries for such applications as cylinder heads, wheels, and lightweight body components. Aluminum alloys are popular in the construction industry, both as structural components and in extruded window frames and the like. Utensils for cooking and other domestic purposes, and the ubiquitous aluminum beverage can are also major uses.

For some of the more demanding applications, as in aerospace or where corrosion resistance is a major factor, the elemental composition of the alloy is critical. Hundreds of specialized alloys

have been developed for different purposes. Various classification systems have been created to describe these materials; one of the most widely used is the International Alloy by Designation System (IADS), based on classifications developed by the Aluminum Association of the United States. This system uses a series of four-digit numbers, the first of which indicates the major alloying element, with the rest used to identify the specific alloy (see Table 1).

Series	Major alloying element(s)	Typical Properties	Typical Application
1xxx	Pure Al (>99%)	Good electrical conductivity, flexible	Electrical cable, packaging foil
2xxx	Cu	High strength	Aircraft structures, automotive bodies
3xxx	Mn	Formability, corrosion resistance	Beverage cans, cooking utensils, construction
4xxx	Si	Good flow characteristics	Forgings, welding alloys
5xxx	Mg	Strength, good corrosion resistance	Construction, storage tanks, marine
6xxx	Mg, Si	High strength, extrudability	Extruded construction & automotive components
7xxx	Zn	Very high strength	Critical aircraft structures
8xxx	Others including Li*	Depends on alloying elements	Special applications

Table 1: The International Alloy Designation System (IADS)

* Aluminum/lithium alloys have exceptional strength/weight characteristics, and are increasingly used in aerospace applications.

In each category, other minor alloying elements are used to achieve performance variations as required. The above classifications cover wrought alloys: a similar series describes casting alloys. The latter has the format 1xx.x, 2xx.x, etc. Again, the first digit indicates the major

alloying element. The next two digits identify the alloy, and the last indicates if it's a casting or an ingot.

Series	Major alloying elements
1xx.x	Pure Al (>99%)
2xx.x	Cu
3xx.x	Si, Cu, Mg
4xx.x	Si
5xx.x	Mg
6xx.x	Unused
7xx.x	Zn
8xx.x	Sn
9xx.x	Others

Table 2: Casting Alloys

Generally, the properties of these casting alloys mirror those of the equivalent wrought alloys. The 8xx.x series of aluminum/tin alloys are materials with very good wear resistance, and are used for slide bearings and similar applications. Other standards exist in different countries, and there are yet more classifications to indicate heat treatments and other processes applied to the material.

Given this multitude of different alloys with widely differing properties, recycling waste aluminum by simply remelting unsorted waste metal is clearly not very efficient. The composite melt may need considerable processing and metallurgy before a secondary material with the desired properties can be produced. Some of the more specialized alloys command premium prices; treating these separately has obvious advantages.

Thus sorting scrap and accurately identifying different alloys prior to melting adds significant value for aluminum recyclers.

Aluminum Recycling

Aluminum recycling has become a significant global industry. Since 2001, for example, the production of secondary aluminum in the U.S. from recycling has actually exceeded that of primary aluminum from smelting (source: USGS). A significant factor has been the aluminum beverage can, one of the most readily recycled aluminum products — not least because the can industry itself provides a ready market for recycled aluminum.

The main benefits of aluminum recycling can be summarized as follows:

- Aluminum has unique recycling qualities: most alloys can be repeatedly remelted without loss of performance
 - Aluminum recycling saves energy: up to 95% of the energy needed to produce the primary metal
 - Aluminum recycling is financially attractive: apart from the energy savings, a ready market exists for secondary aluminum
- New scrap — waste material from the manufacture of aluminum articles. This may well be of known origin and composition.
 - Old scrap — material recovered after an aluminum article is discarded at the end of its useful life. Such scrap could be, e.g., profiles, offset printing plates, automotive components such as cylinder heads and wheel rims, window frames, old electrical conductors, packaging scrap, aircraft components, etc.. Legislation such as the European Community's ELV (End of Life Vehicles) Directive requires the environmentally responsible disposal of such materials, and encourages recycling.
 - Dross — the residue from other smelting and refining processes, this is usually heavily contaminated with other metals, and needs extensive processing before usable aluminum can be recovered.

The basic recycling process is simple: the scrap is charged into a reverberatory furnace and melted; the molten metal is then cast into suitable ingots. Different types of scrap may require different treatments. The main types of scrap received for recycling are:

- Used beverage containers (UBC) — Systematically collected in some countries, often these can be part of a "closed loop" process, whereby cans are simply melted to produce the metal needed for new cans.



Clearly, the level of processing required for these different types of scrap increases as the material's origin becomes less certain. The first two categories are normally handled by "remelters"; the rest are processed by "re-refiners." The basic aluminum recycling process could be summarized as below:

Scrap Collection and Sorting



Scrap Trade



Dismantling

Cleaning

Shredding

Separation



Remelting/Refining

At each of these stages, it is possible to add value by identifying and separating the different materials in the scrap. As mentioned previously, aluminum alloys can be melted down and reused without loss of their basic performance properties. This is a real incentive to identify the alloy before remelting. In the case of new scrap, identification can be fairly straightforward, provided an audit trail of the scrap material can be maintained. If not, or if old scrap is being processed, physical examination is rarely sufficient for a positive identification.

Because of the financial and environmental benefits of knowing scrap composition before remelting, scrap quality standards have been developed and codified.

In the European Community, DIN EN 13920-1:2003 identifies 15 different categories of aluminum scrap, specified in part by their overall elemental composition. In the U.S., the Institute of Scrap Recycling Industries (ISRI) also publishes aluminum scrap categories.

The DIN EN 13920 categories are:

DIN EN 13920-2	Unalloyed Aluminum
DIN EN 13920-3	Wire and cable scrap
DIN EN 13920-4	Scrap consisting of one single wrought alloy
DIN EN 13920-5	Scrap consisting of two or more wrought alloys of the same series
DIN EN 13920-6	Scrap consisting of two or more wrought alloys
DIN EN 13920-7	Scrap consisting of castings
DIN EN 13920-8	Scrap consisting of non-ferrous materials from shredding processes destined to Aluminum separation processes
DIN EN 13920-9	Scrap from Aluminum separation processes of non-ferrous shredded materials
DIN EN 13920-10	Scrap consisting of used Aluminum beverage cans
DIN EN 13920-11	Scrap from aluminum-copper radiators
DIN EN 13920-12	Turnings consisting of one single alloy
DIN EN 13920-13	Mixed turnings consisting of two or more alloys
DIN EN 13920-14	Scrap from post-consumer aluminum packagings
DIN EN 13920-15	Decoated aluminum scrap from post-consumer aluminum packagings
DIN EN 13920-16	Scrap consisting of skimmings, drosses, spills and metallics

The Need for Alloy Identification

Most of the above categories have limits on purity and on the content of various alloying and contaminant elements. For example, scrap conforming to DIN EN 13920-2 would have an aluminum yield of 95% and the following maximum impurity levels:

silicon $\leq 0.25\%$, iron $\leq 0.4\%$,
copper $\leq 0.05\%$, manganese $\leq 0.05\%$,
magnesium $\leq 0.05\%$, zinc $\leq 0.07\%$,
titanium $\leq 0.05\%$, and others $\leq 0.05\%$.

Certainly, any scrap dealer or trader that can supply scrap conforming to these norms can command a higher price and gain commercial advantage. In some cases, it may be possible to optimize the scrap for a particular customer by mixing materials of different grades, but it is clearly essential to have confidence in the properties of the available stock.

At the refiner, the issue of output quality also becomes significant. Because of the importance of secondary aluminum, a number of recycle-friendly alloy specifications have been developed to facilitate recycling. Some refiners produce alloys with deliberately high contents of alloying elements that can be blended with other alloys to produce the desired result. Of course, the purchaser of the final secondary alloy demands a specification and certificate of analysis to confirm the alloy's actual composition.

In the initial stages of processing, at the scrap dealer or collector, magnetic separators are commonly used to differentiate between ferrous and

nonferrous scrap. These devices can't differentiate aluminum from materials such as magnesium alloys or nonmagnetic stainless steels, and they certainly can't differentiate among the different alloys.

The only reliable way of differentiating the various alloys and discriminating between aluminum-based materials and others is elemental analysis.

Many elemental analytical techniques require samples to be analyzed in the laboratory, but this is usually impractical for scrap sorting. The laboratory is often located off-site, so sample transport takes far too long. Also, laboratory analysis is usually too expensive relative to the value of the material being tested. Very often, the price paid for scrap is agreed when the consignment arrives at a dealer's premises, so very fast analysis is required. Similarly, a consignment may contain numerous items; for a representative result, many accurate analyses are needed in a short time. Scrap usually comes in a variety of shapes and sizes; any analysis technique used must be able to cope with this as well.

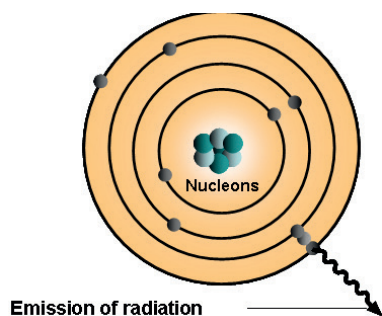
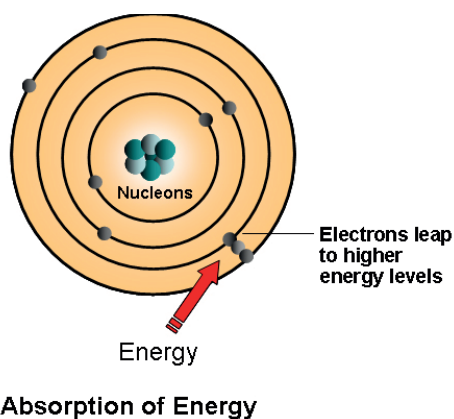
In summary, the ideal scrap analysis instrument should be fast, accurate, portable, and simple to use on site. It should also require minimal sample preparation.

Instrumental Solutions

The right handheld X-ray fluorescence (XRF) spectrometer can satisfy most aluminum recycling analysis requirements.

Example: the SPECTRO xSORT handheld analyzer employs the latest XRF technology to provide a comprehensive, easy-to-use solution for numerous scrap metal sorting applications.

For even more challenging requirements, the answer may be the larger, more powerful SPECTROTEST. This mobile optical emission spectrometry (OES) analyzer is also fully at home in scrap industry working conditions.



The spectrometric principle in action: X-rays excite the inner electrons, which emit characteristic energy as they return to normal.

XRF and OES instruments can be used by operators without analytical expertise to return accurate analyses of even complex alloys in seconds rather than minutes or hours, and to deliver reliable alloy identification.

Both techniques work on the spectroscopic principle, which relies on the internal atomic structure of the material being analyzed. The atoms of the sample are excited by an external source of energy, which is absorbed by and raises the energy level of the electrons in the sample atoms. This excited state is unstable. So the electrons rapidly return to their normal state, emitting energy as they do so.

This emitted energy, or emission spectrum, is characteristic of the elements contained in the sample. Its intensity is proportional to their

concentration. The two techniques, XRF and OES, differ in the type of energy used to excite the sample atoms: in the former, it's a beam of X-rays, and in the latter, an electric arc or spark. The relevant aspects of the instruments are covered below.

SPECTRO xSORT

Instrument Highlights

The design, performance, and simple operation of the SPECTRO xSORT handheld spectrometer make it ideal for aluminum scrap sorting and other metal recycling applications. Its XRF spectrometry is a well-proven technique for metals analysis, popular since its introduction in the 1950s.



The technique works by irradiating the surface of the sample with a beam of X-rays. This induces fluorescence in the atoms of the sample, which is then re-emitted as X-rays of a lower energy. Each element emits X-rays of a different and unique energy or wavelength, whose intensity is proportional to the concentration of that element in the sample. The analyzer's detection technology can discriminate among

the fluorescent X-rays emitted, and measure each one's intensity — hence determining the concentration of the different elements in the sample.

SPECTRO Analytical Instruments has supplied X-ray spectrometers to the metallurgical industries for many years. That experience is built into SPECTRO xSORT. So it can discriminate quickly and easily between many alloy types, and also identify specific alloys within those groups.

The latest SPECTRO xSORT models have been optimized for fatigue-free, on-site analysis. Complete with battery pack, the analyzer weighs less than 4 pounds (1.64 kilograms) and features an ergonomically designed “pistol grip” handle. To operate, the user grips the handle, presses the flexible X-ray safety gasket onto the surface of the test sample, and pulls the trigger. The user interface and results are displayed on an optimally positioned touchscreen. The instrument is robust, with a housing of shock-resistant ABS plastic. When not in use, it can be carried in a convenient holster.

Users may choose a complete analysis, or have the instrument compare the analysis against its extensive internal alloy library and display only the material's grade specification on the screen:

Even more convenient in some situations, SPECTRO xSORT can show a simple Pass/Fail message, using the first sample measured as a reference and comparing all subsequent test pieces to it

The predefined grade library delivered with the instrument can be easily extended by adding data from the optional SPECTRO Metals Database. Customized new grade libraries may also be created. All results can be stored in the instrument, or sent to a USB drive, network, or printer as XML or PDF files, via wireless Bluetooth interface. An optional integrated camera can even add images of the sample measured.

The instrument uses stored calibrations combined with SPECTRO's unique iCAL (intelligent calibration logic) software. With any XRF instrument, these calibrations must be checked periodically against a known standard to standardize the system. SPECTRO xSORT is fitted with an automatic shutter that fulfills two purposes: to protect internal components, and to serve as sample material for the iCAL standardization. Any calibration adjustments are made automatically. No separate sample or tedious operator standardization routine is required.

Little sample preparation is normally needed. Oil or grease on the sample surface can simply be wiped away. Some conditions or finishes that could affect results — partly because X-ray analysis detects both surface and underlying metals — can usually be overcome by grinding back the surface using a suitable abrasive. Examples where this might be necessary include:

- Heavily oxidized, uneven, or scaled surfaces

Light Elements PP4			
6061			
6061 (20% 9/0/0)			
Si	0.60	Cu	0.30
Mn	.063	Mg	1.02
Zn	.092	Fe	0.42
Ni	.013	Pb	.009
Ti	.030	Cr	0.26
V	.012	Sr	.003
Zr	.003	Bi	.007
Ready to measure (Film: PP4)			

Light Elements PP4
6061
6061 (20% 9/0/0)
B 209 6061
Ready to measure (Film: PP4)

- Plated parts, e.g. Alclad, a material used in aircraft construction, wherein aluminum alloy is coated with a few microns of pure aluminum as corrosion protection
- Painted or plastic-coated items

Light Element Performance

Light elements such as magnesium and silicon have become increasingly important in aluminum metallurgy, as more and more alloys are developed that take advantage of their desirable performance characteristics.

Unfortunately, these elements are traditionally more difficult to measure via XRF than heavy alloying elements like copper and zinc.

However, the latest SPECTRO xSORT models utilize a miniaturized, low-power X-ray tube rated at 50 kilovolts (kV), with a rhodium anode, providing exactly defined excitation for excellent stability and precision. This is complemented by a new high-count readout system and a high-resolution, high-sensitivity silicon drift detector (SDD). (These technologies are versions of those used in high-performance laboratory instruments like the top-of-the-line SPECTRO XEPOS analyzer.) Combined, they enable the handheld SPECTRO xSORT to furnish accurate, high-productivity spectrochemical analysis and screening of numerous elements in aluminum alloy recycling — including such difficult-to-analyze light metals as magnesium and silicon.

So SPECTRO xSORT can differentiate between various aluminum alloys on

the basis of their magnesium or silicon content in 7 seconds.

This timeframe is conducive to high productivity, and to operator comfort in keeping a handheld instrument stationary on a sample. Note that some XRF handhelds had difficulty in measuring these light elements. Readings may be at or below their limits of detection (LODs). Such instruments required a substantially longer time — perhaps 60 seconds — for reliable measurements in these cases.

Also, other instruments may require the path of the X-ray beam to be flushed with helium gas, or to be maintained in a vacuum, during the measurement. SPECTRO xSORT measures every sample — even those containing light elements — in air, with no method switching, helium purge, or vacuum.

The limits of detection of various elements that may be encountered in aluminum-based alloys are shown in Table 3. The data represents measurements of pure single-element standards at measuring times of 2 seconds and 20 seconds for the light elements magnesium and silicon.

Element	LOD [%]
Ag	0.003
Bi	0.003
Cd	0.004
Co	0.003
Cr	0.004
Cu	0.002
Fe	0.005
Mg	0.1
Mn	0.002
Mo	0.001
Nb	0.001
Ni	0.008
Pb	0.003
Sb	0.005
Sc	0.01
Si	0.03
Sn	0.003
Sr	0.001
Ti	0.01
V	0.006
Zn	0.01
Zr	0.001

Table 3:
Limits of Detection (LODs) (%)



The following charts show measured and certified values for various elements in typical aluminum alloys.

As the data shows, recent SPECTRO xSORT improvements mean that most light elements no longer present it with a serious challenge in identifying and sorting aluminum alloys. This can prove particularly useful when operators need to sort incoming samples into a large number

of specific wrought alloy and cast alloy grades.

SPECTRO xSORT was able to provide reliable identification and measurement of previously difficult light element components with twice (2X) the precision of previous models — and in half the time. The instrument can now successfully sort wrought alloys in the 2014/2024, 7050/7075, 6061/6063, and even 1100

Tables: Identification and analysis of various aluminum alloys. Average of five measurements carried out with SPECTRO xSORT.

2014				
Element	Measurement time	Measured Value [%]	Standard Deviation [%]	Actual Value [%]
Al	20s	92.9	0.1	92.89
Bi	2s	0.028	0.003	0.025
Cr	2s	0.028	0.002	0.05
Cu	2s	4.48	0.01	4.26
Fe	2s	0.459	0.004	0.46
Mg	5s	0.49	0.10	0.45
	20s	0.41	0.10	
Mn	2s	0.775	0.006	0.81
Ni	2s	0.043	0.002	0.028
Pb	2s	0.023	0.001	0.023
Si	5s	0.81	0.02	0.88
	20s	0.75	0.02	
Sn	2s	0.031	0.002	0.037
Ti	2s	0.035	0.001	0.03
V	2s	0.02	0.003	0.018
Zn	2s	0.033	0.001	0.029

2024				
Element	Measurement time	Measured Value [%]	Standard Deviation [%]	Actual Value [%]
Al	20s	92.7	0.13	92.51
Bi	2s	0.008	0.002	0.008
Cr	2s	0.031	0.003	0.028
Cu	2s	4.55	0.07	4.55
Fe	2s	0.26	0.006	0.25
Mg	5s	1.47	0.15	1.57
	20s	1.3	0.11	
Mn	2s	0.65	0.008	0.66
Ni	2s	0.045	0.003	0.031
Pb	2s	<0.005		
Si	5s	0.18	0.03	0.25
	20s	0.21	0.017	
Sn	2s	0.013	0.003	0.015
Ti	2s	0.039	0.001	0.032
V	2s	0.016	0.004	0.022
Zn	2s	0.075	0.007	0.073

6061				
Element	Measurement time	Measured Value [%]	Standard Deviation [%]	Actual Value [%]
Al	20s	97.31	0.09	97.23
Cr	2s	0.25	0.002	0.229
Cu	2s	0.314	0.002	0.3
Fe	2s	0.353	0.001	0.35
Mg	5s	1.01	0.09	1
	20s	0.95	0.08	
Mn	2s	0.053	0.001	0.052
Ni	2s	0.063	0.001	0.053
Si	5s	0.58	0.03	0.64
	20s	0.56	0.02	
Ti	2s	0.038	0.008	0.037
Zn	2s	0.089	0.001	0.08

6063				
Element	Measurement time	Measured Value [%]	Standard Deviation [%]	Actual Value [%]
Al	20s	98.4	0.06	97.63
Cr	2s	0.013	0.001	0.006
Cu	2s	0.008	0.001	0.011
Fe	2s	0.21	0.003	0.19
Mg	5s	0.79	0.1	0.64
	20s	0.74	0.06	
Mn	2s	0.023	0.002	0.013
Pb	2s	0.019	0.002	0.011
Si	5s	0.47	0.02	0.42
	20s	0.45	0.02	
Ti	2s	0.024	0.001	0.014
Zn	2s	0.021	0.001	0.012

1100				
Element	Measurement time	Measured Value [%]	Standard Deviation [%]	Actual Value [%]
Al	20s	99.1	0.01	99.11
Cr	2s	0.029	0.003	0.021
Cu	2s	0.148	0.002	0.14
Fe	2s	0.503	0.002	0.5
Mg	5s	<0.19		-
	20s	<0.1		
Mn	2s	0.028	0.001	0.032
Si	5s	0.17	0.011	0.1
	20s	0.081	0.008	
Ti	2s	0.032	0.003	0.027
V	2s	0.008	0.002	0.02
Zn	2s	0.0351	0.0004	0.029

7050/7075					
Element	Measurement time	7050 Measured Value [%]	Standard Deviation [%]	7075 Measured Value [%]	Standard Deviation [%]
Al	5s	89.5	0.17	89.2	0.08
	20s	89.4	0.13	89	0.07
Cr	2s	0.015	0.002	0.26	0.003
Cu	2s	2.18	0.009	1.63	0.01
Fe	2s	0.13	0.002	0.19	0.003
Mg	5s	1.98	0.18	2.19	0.2
	20s	2.09	0.1	2.3	0.13
Mn	2s	0.007	0.001	0.035	0.002
Ni	2s	0.021	0.003	0.024	0.002
Si	5s	0.11	0.015	0.17	0.02
	20s	0.1	0.007	0.17	0.005
Ti	2s	0.036	0.002	0.047	0.004
Zn	2s	5.89	0.01	5.99	0.017
Zr	2s	0.11	0.001	0.041	0.001

For the identification and separation of 7050 and 7075, determining the correct Mg level is critical. The differentiation of these two very similar grades can then be carried out based on the Zr content.

grade series, where magnesium is a critical component, sometimes in combination with other elements, in only 7 seconds! So recyclers can now separate more grades in less time.

In summary, the SPECTRO xSORT handheld XRF analyzer provides good results in a timely fashion for most grades of aluminum and aluminum alloys, including wrought and cast alloys. Of particular note is its enhanced performance with alloys containing certain light elements. The instrument lets users identify and sort more alloys, faster, with greater precision. As these results show, SPECTRO xSORT is ideal for most scrap sorting tasks encountered in the aluminum recycling industry.

When the handheld SPECTRO xSORT is not suitable, SPECTRO Analytical Instruments offers an even more powerful mobile solution: SPECTROTEST.



SPECTROTEST

Instrument Highlights

In some recycling applications, even more precise metal analysis is required than SPECTRO xSORT can provide, or materials may be even more difficult to identify — for example, in cases where aluminum alloys contain trace amounts of lithium. These circumstances may call for the SPECTROTEST arc spark optical emission spectrometry (OES) analyzer. Compared to SPECTRO xSORT, it offers a larger but still mobile, field-ready form factor, combined with superior portable performance.

Aluminum/lithium compounds represent a new generation of materials with exceptional strength/weight properties. This makes them ideal as wrought alloys for important aerospace and military applications. However, their appearance in a recycling stream can be problematic: more than 5 parts per million (ppm) lithium content can cause difficulties in casting a recycled aluminum alloy. When incoming materials may include these alloys, it's often important to identify them in scrap.

The SPECTROTEST mobile metal analyzer utilizes the OES principle. In this technique, the atoms in the sample are excited not by X-rays but by an electric arc or spark, so that each element emits light of characteristic wavelengths in the ultraviolet and visible regions of the spectrum. The arc or spark is generated at a sample probe on a flexible umbilical cord up to 8 meters (m) long. As with SPECTRO xSORT, the operator simply places the probe in contact with

the sample to take a measurement. (Because metal atoms are expelled from the surface during an arc spark measurement, a small burn mark occurs on the surface of the sample.) Light emitted by the sample is transferred via fiber optic to the optical system, where it is separated into its different wavelengths using a diffraction grating. Individual intensities are then measured with a suitable detector.

SPECTROTEST employs a detector that's state-of-the-art: highly sensitive, fast multiple CCDs deliver high-speed analysis and generate high-quality data. This enables the same sophisticated approach to data handling as in SPECTRO xSORT. So SPECTROTEST uses unique iCAL procedures, and can identify and verify alloys automatically in seconds.

The physical dimensions of its optical system mean that SPECTROTEST at 64 lb (29 kg) is larger and less easily portable than SPECTRO xSORT, although its long sample probe allows flexible sample access.

Light Element Performance

SPECTROTEST can detect not only all the elements of interest in routine scrap sorting, but also lighter metals like lithium or beryllium that are beyond the performance threshold of handheld XRF analyzers. The following results were obtained with a SPECTROTEST on samples of aluminum alloys prepared by surface grinding. Each value is the average of three separate readings.

4015 Alloy			
Element	Certified Value [%]	Measured Value [%]	Standard Deviation [%]
Si	1.82	1.86	0.0054
Fe	0.43	0.41	0.0130
Cu	0.196	0.18	0.0006
Mn	1.070	1.06	0.0120
Mg	0.450	0.43	0.0030
Zn	0.050	0.044	0.0018
Cr	0.043	0.038	0.0010
Ti	0.030	0.026	0.0023
Be	0.0038	0.0037	0.0001
Li	0.0006	0.0004	0.0001
Al	Balance	96.36	0.0290

Alloy type	Certified Value for Li [%]	Measured Value [%]	Standard Deviation [%]
1050	0.0021	0.0022	0.0001
1200	0.0015	0.0012	0.0001
6151	0.0007	0.0007	0.0001

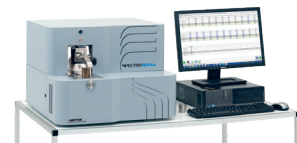
SPECTROTEST offers much of the functionality and performance of a benchtop laboratory analyzer, with all the convenience of on-the-spot analysis. With its large metals database and powerful analytical technologies, it can identify virtually any common commercial metal alloy — while easily accommodating new alloys or materials. It's an especially good solution for recycling tasks such as analysis of aluminum alloys containing lighter elements like lithium.

Additional Solutions: Laboratory Instruments

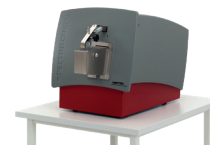
When analytical results of the highest quality are required, consider the low detection limits, accuracy, and speed of analysis achievable with SPECTRO's high-performance OES analyzers such as SPECTROCHECK, SPECTROMAXx and SPECTROLAB. Full details of these instruments can be found on the SPECTRO website at www.spectro.com



SPECTROLAB



SPECTROMAXx



SPECTROCHECK

Conclusion

Elemental analysis of aluminum alloy samples — including those containing previously difficult-to-measure light elements — can improve efficiency and add value within the aluminum recycling process. Portable and mobile spectrometers from SPECTRO Analytical Instruments can provide accurate, rapid, and reliable alloy identification on site.

Choosing a handheld XRF analyzer

Handheld XRF spectrometers are not created equal. Make sure the instruments you consider can meet the needs of your specific PMI tasks with the right mix of proven performance, innovative features, and tested convenience. Look for the following benefits:

Field-proven performance and speed. Consider models that have proved they can perform well in challenging plant or field locations. One key for highly reliable yet high-volume PMI: the ability to deliver laboratory-quality results in seconds.

Operating flexibility. Some older models require time-consuming procedures such as switching analytical methods between samples, or demand helium purges or vacuum for accurate operation. Find an instrument that lets you analyze the alloys you need: simply, easily, and quickly.

Documentation/connection flexibility. Why get stuck with limited choice of results formats to document compliance? Flexible SPECTRO xSORT lets you save results in different formats at different destinations simultaneously. Save to USB drive, network, or printer as XML or PDF, and (via an integrated camera) combine with images of the sample measured.

Easy standardization and built-in protection. Try to find instruments that avoid tedious multiple-sample standardization. Example: SPECTRO xSORT provides unique one-sample, one-time standardization. The shutter even functions as the system's standardization sample, while also offering built-in protection of detector and tube, even when analyzing light elements.

Large metals database. Choose devices that can easily accommodate new alloys (e.g., with light elements) or materials. For instance, SPECTRO xSORT lets you extend prepackaged libraries and/or create new customized grade libraries.



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RESOURCE LIBRARY

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