Transform Your Sorting System with the SpeedSorter™ LIBS Sensor

The use of sensor-based separation can radically improve the purity of high-value aluminium produced in recycling separation processes. Integrating Laser-Induced Breakdown Spectroscopy (LIBS) sensors into the sorting process can revolutionize operations, offering higher throughput and improved yield in separating metal alloys.

The SpeedSorter™ LIBS sensor enhances material recovery while reducing costs and boosting overall productivity. By leveraging advanced LIBS techniques, the SpeedSorter™ ensures high-purity outputs and a streamlined, high-throughput recycling process. Discover how SpeedSorter™ can transform your sorting system and improve your scrap recycling profits by producing high-value furnace-ready alloys.

Introduction

Purity and yield are the key ingredients to maximizing material recovery and profitability in scrap processing. Integrating advanced LIBS sorting modules into the sorting system can enhance operations above the use of X-ray and camera technologies. The capability of LIBS to detect and monitor concentrations of light elements puts it at the cutting edge of scrap processing, especially in the production of high-value aluminum materials. In addition to its measurement capabilities, LIBS does not require radiation certification and testing for use.

Optimizing Alloy Purity in Scrap Processing

Aluminum is one of the most recycled metals globally, prized for its lightweight nature, corrosion resistance, and infinite recyclability. Commonly recycled aluminum alloys include the 5xxx and 6xxx series used in automotive, aerospace, and construction industries. Various pre-sorting systems are employed to achieve purity levels required for the 5xxx and 6xxx series alloys from mixed scrap streams. Magnetic separation is typically used to eliminate ferrous scrap, while X-ray sorting (XRF) identifies and segregates scrap with high copper and zinc content. Both magnetic separation and XRF are limited in their ability to detect non-ferrous material and light elements like magnesium (Mg) and silicon (Si) alloyed in the 5xxx and 6xxx series alloys. Weaker signals from the light elements make them difficult for XRF detectors to measure accurately and/or fast enough, especially in complex alloy compositions.

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Scrap processors benefit from sorting high-value alloys using advanced technologies. Techniques such as Laser-Induced Breakdown Spectroscopy (LIBS) are often employed to overcome the limitations of XRF and enable precise in-line separation of alloys. LIBS techniques offer in-line separation without the need for extensive preprocessing, ensuring that the recycled stream meets stringent alloy specifications required for sorting high-quality alloys. The SpeedSorter™ LIBS Sensor by Ocean Optics is an advanced, high-throughput sensing system designed for in-line sorting of non-ferrous scrap metals, particularly effective in challenging industrial environments. The SpeedSorter™ is optimized for sorting wrought alloys from cast, 5xxx aluminum from 6xxx aluminum and cleaner alloys extracted from mixed scrap. The SpeedSorter™ also enables extraction of aluminum from scrap containing copper, iron or zinc-based alloys.

Laser-Induced Breakdown Spectroscopy (LIBS)

LIBS measures elemental composition by focusing a pulsed laser on a sample surface, generating a plasma that includes a small amount of the sample material. The optical emission measured from the bright plasma is representative of the sample composition, allowing determination of alloying elements in aluminum. LIBS is especially sensitive to alkali metals and alkaline earth metals, enabling magnesium detection. Additionally, LIBS measures silicon at levels much lower than X-ray devices. The Ocean Optics SpeedSorter™ brings the power of LIBS to in-line measurements for scrap sorting. LIBS systems can be integrated into existing recycling lines and customized to meet specific processing requirements.

LIBS technology operates at high speeds, which enables the processing of large volumes of scrap metal quickly. In fact, in systems where the SpeedSorter™ is used, the material handling system is the rate limiting feature. Because of this speed the overall efficiency of the recycling process is increased. The impact of this improved efficiency and accuracy is increased profits, based on the speed with which high-purity materials can be produced with high throughput. Increased profits come with environmental benefits that result from the lower energy cost of recycling versus primary generation, contributing to a reduction in the carbon footprint associated with metal production and recycling.

SpeedSorter™ LIBS Sensor

By utilizing advanced sorting technologies such as LIBS, metal recyclers can achieve high-purity separations of valuable alloys, enhancing the efficiency and profitability of their recycling operation. An example workflow for inline sorting of scrap using the SpeedSorter™ is shown in Figure 1.

System Workflow

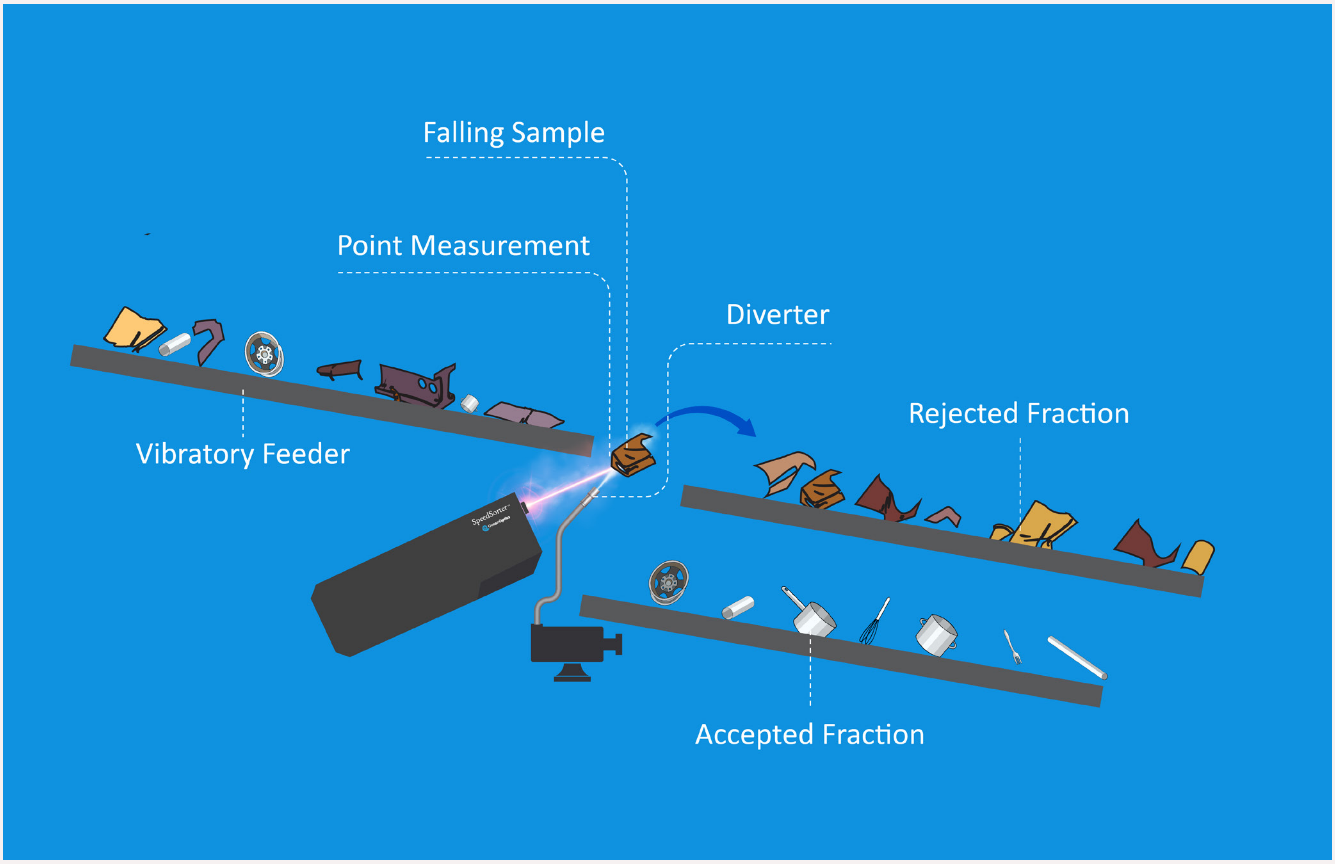

Figure 1. System workflow using the SpeedSorter™ to sort scrap metal.

The SpeedSorter™ is mounted in a fixed position, inside a laser-safe enclosure that fully shields nearby workers from any glancing angle or reflection from the laser beam, including when it may reflect randomly off a scrap sample. Sorting begins when the laser and material handling system are enabled. The material handling system supplies individual scrap samples at high speed for processing. Assuming a part speed of 2.5m/s, the parts should be separated by at least 30 mm. Adjusting material feed rate will require adjustment in minimum distance between parts. It is critical that a portion of the parts' surface passes through the laser's focal point of 250 mm. The laser then ablates a small portion of the metal, which produces a plasma that emits light. The spectrometer analyzes the light collected from the plasma, and the software determines if the part meets or does not meet thresholds that correspond to the type of desired metal sort. The system sends out a pulse to a customer's diverter mechanism to physically move the part to a desired material stream.

Aluminum Separation with the SpeedSorter™

The power of the SpeedSorter™ is demonstrated through accurate aluminum separation using clean samples to simulate post-production stamping waste. The SpeedSorter™ software collected plasma spectra from the samples, and the processed spectra were used to create separation schemes. The high magnesium content in 5xxx series aluminum allows for separation from 6xxx series resulting in high purity separation. Further separation based on lower magnesium levels can differentiate 6xxx series from 1100 alloy, though with slightly less pure product. Zinc content signals enable separation of 7075 alloy from other alloys with high purity.

The tested material was a mix of Arconic Standard Reference Materials and cut segments of clean material purchased from McMaster-Carr. Several samples of each type (5xxx series, 6xxx series, 7075 and 1100) were hand-dropped onto a chute positioned to deliver the samples to the optimal sensor working distance. As the pieces fell through the laser interrogation region, analytical plasmas were generated, and plasma emission collected with the spectrometer. The software used levels set by the user to guide the material handling system to direct the material to one of two result regions.

The SpeedSorter™ software was used to collect plasma spectra from the samples. Processed spectra were stored, and the ratioed output used to create the separation scheme. Figure 2 shows the ratios acquired from 5xxx and 6xxx series aluminum pieces. It is clear from these results that the high magnesium content associated with the 5xxx series can be measured and used to separate these pieces from the 6xxx series, using a threshold of around 200. There is sufficient signal level difference between these two families that a binary sort using these two sets of materials will be separated with high purity.

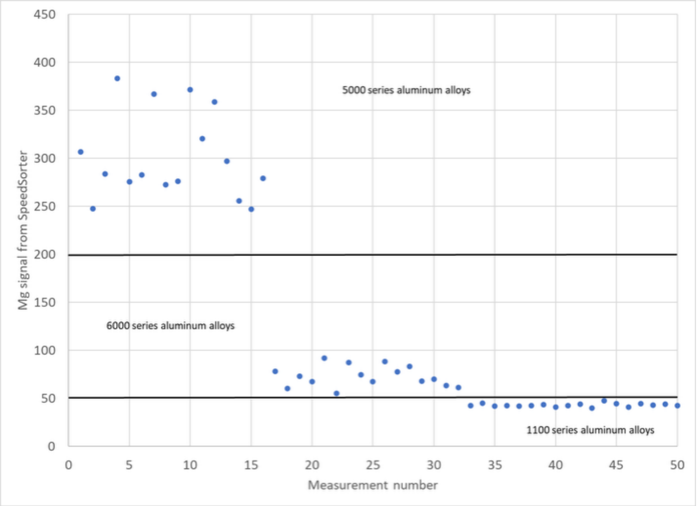

Figure 2. SpeedSorter™ output used to demonstrate a magnesium separation of 5xxx/6xxx/1100 pieces.

If further separation with lower magnesium levels is desired, ratio levels from this element can be used to differentiate the 6xxx family from the 1100 alloy. The threshold associated with this separation is about 50, as shown in the figure. Note that because there is not as large a difference between the signal levels of these two alloy families as between the 5xxx and 6xxx representatives, this separation may result in slightly less pure product.

Another simple and effective separation is shown in Figure 3. Using signals associated with zinc, pieces of 7075 alloy are readily separated from all the others in the demonstration set with a wide margin, indicating that this binary sort would result in high purity 7075 being identified for a material handling system to divert.

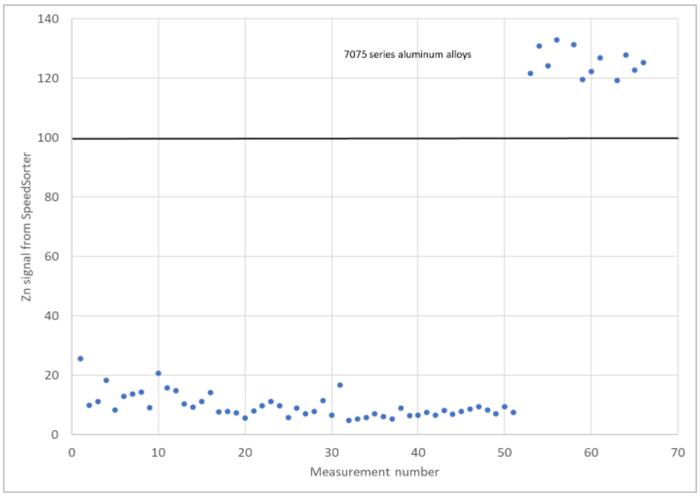

Figure 3. SpeedSorter™ output used to demonstrate separation based on zinc content.

As shown in the results, the Ocean Optics SpeedSorter™ can be implemented into a non-ferrous sorting machine or facility to accomplish aluminum alloy separations with high purity. This is especially beneficial when the use cases demand high precision for specific alloys or series.

Conclusion

The Ocean Optics SpeedSorter™ LIBS sensor can be implemented into non-ferrous sorting machines or facilities to achieve high-purity aluminum alloy separations. This technology is especially beneficial for applications requiring furnace ready materials.

The use of SpeedSorter™ is being extended to other metals and adjacent materials based on this success. For more information, contact Ocean Optics.