



A practical guide to improving steel manufacturing processes and production methods

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Overview

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Manufacture clean steel that meets the most stringent customer requirements

The steel industry faces increasing demand for clean and ultraclean steel with improved mechanical properties. With efficiency and sustainability in mind, steel producers also strive to produce quality strip in a manner that maximizes mill yield and minimizes scrap while meeting stringent customer specifications for thickness, width, hardness, and strength.

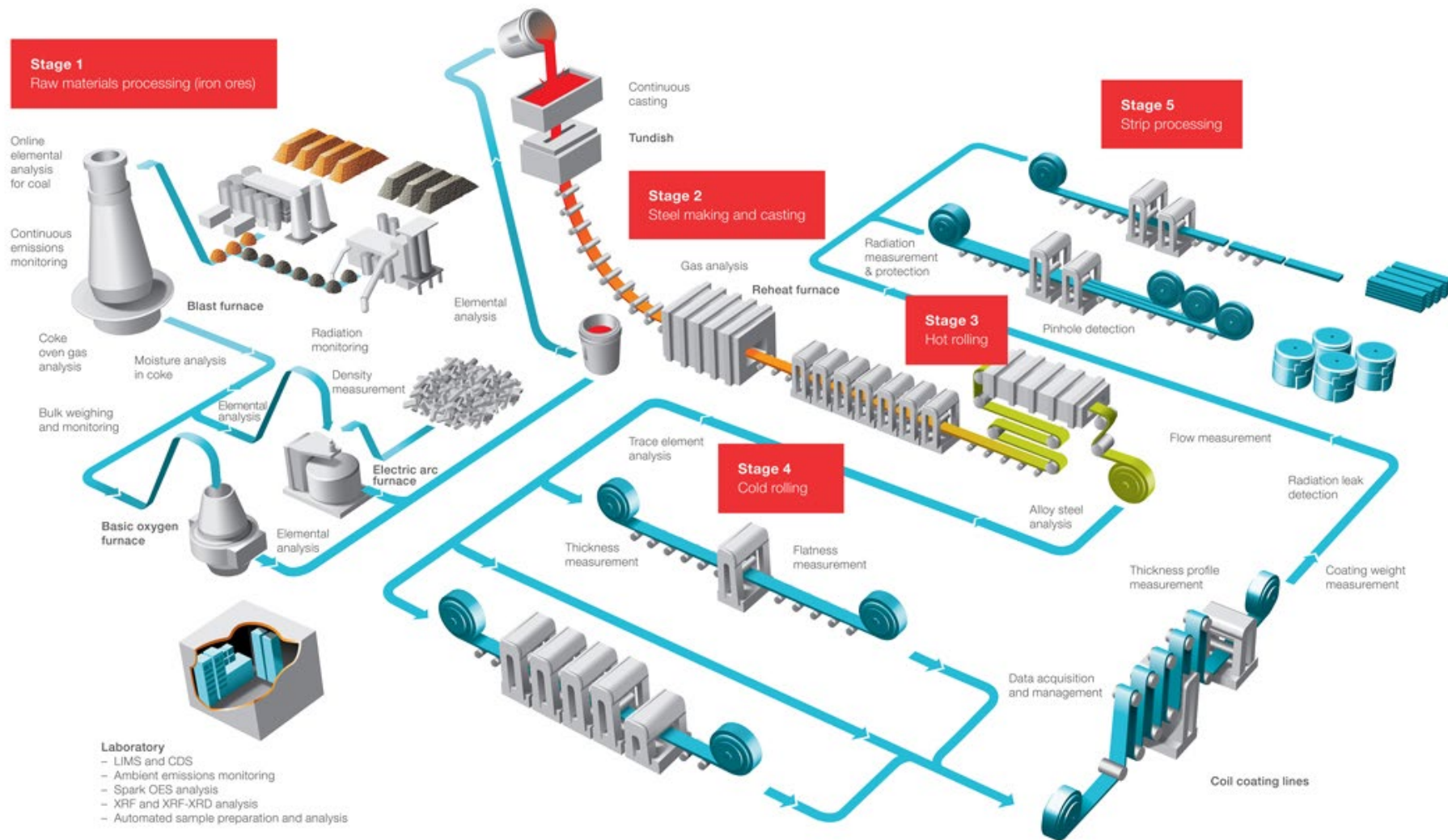
Whether you're producing steel from iron ore or scrap, and your end product is several inch-thick slabs or galvanized sheet less than a millimeter thick, the following pages introduce technologies that will help improve each stage of the steel manufacturing production process, from incoming raw materials to the final coating line.



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The metals making process

Steel process map



Quality and efficiency opportunities



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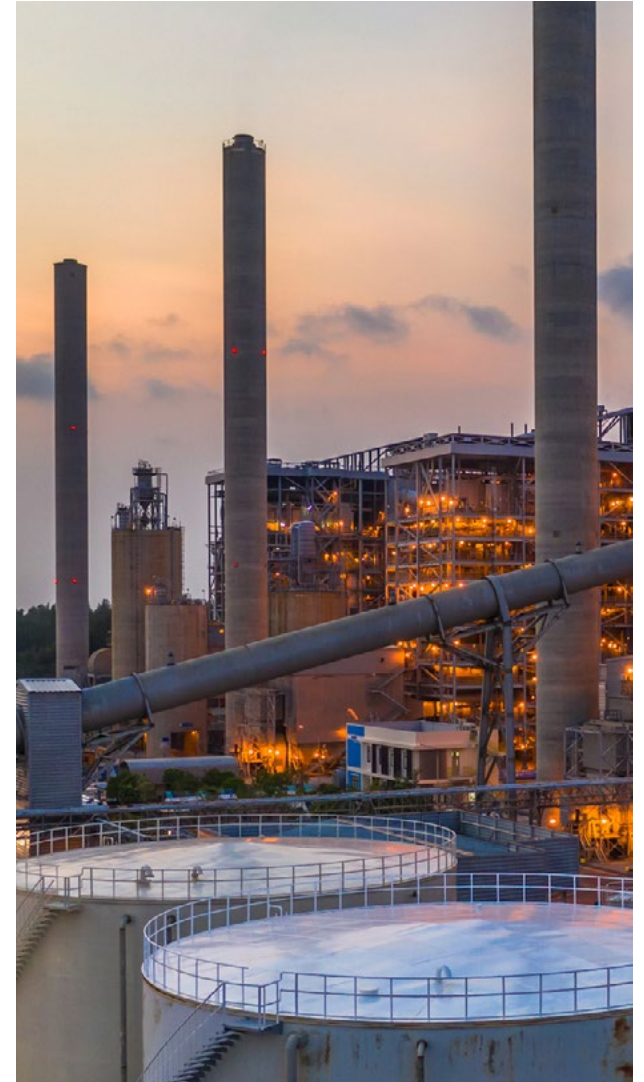
Verifying materials

Analyzing and verifying your materials –
from beginning to end

Steel manufacturing facilities meet quality standards by utilizing both handheld X-ray fluorescence instruments and OES metal analyzers for examination of raw materials, slag, trace and alloying elements throughout production.

Demanding steel plants, pure metals producers and companies needing the best determination of all the elements turn to the Optical Emission Spectrometers for high accuracy analysis of iron and steel from trace to alloying element levels.

Online PGNAA elemental analyzers are used in the sinter feed application as chemical composition is one of the most important parameters for the efficiency of the sinter process.



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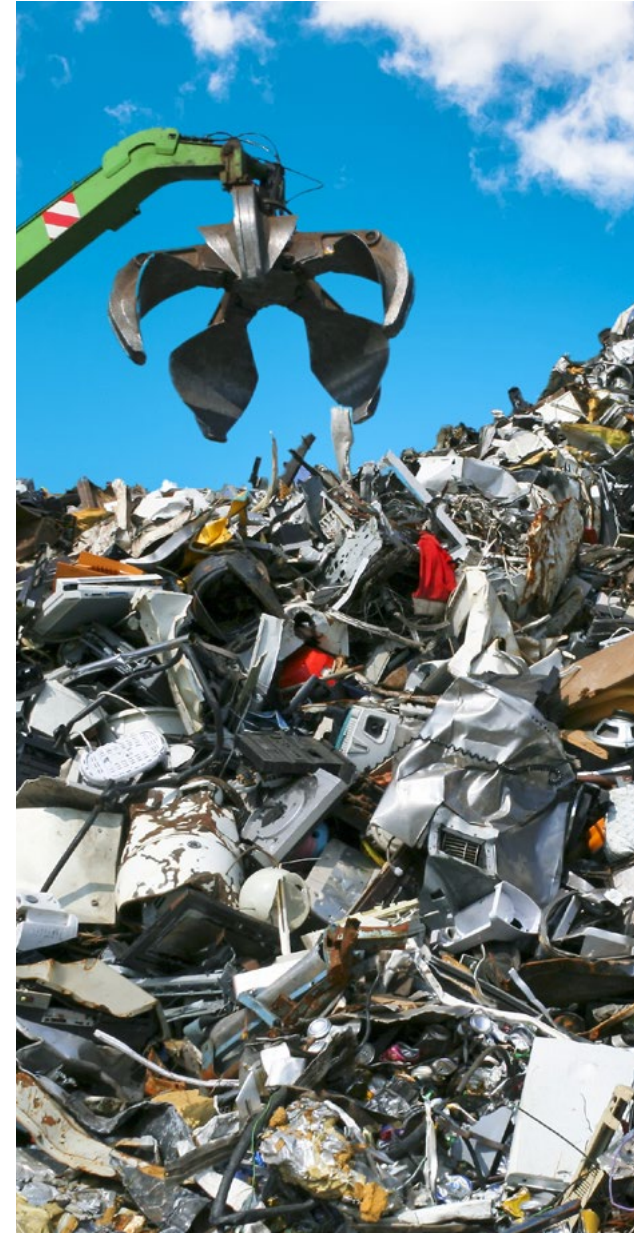
Analyzing scrap

Using scrap metal as a raw material

Manufacturing steel from scrap yields energy and green-house emissions savings. However, the addition of scrap into the steel production line is a major challenge for the industry.

Compared to the clean raw material to which manufacturers are accustomed, post-consumer scrap is composed of an unknown mixture of metals, alloys, and grades. It may be contaminated by radioactive sources or other hazardous elements.

With product quality, process integrity, safety, and regulatory compliance at risk, steel producers can rely on handheld x-ray fluorescence (XRF) analyzers to know the exact grade and composition of the scrap material being introduced into the process. Radiation monitoring portals, personal radiation detectors, and Geiger counters should be utilized before and after the scrap enters the facility.



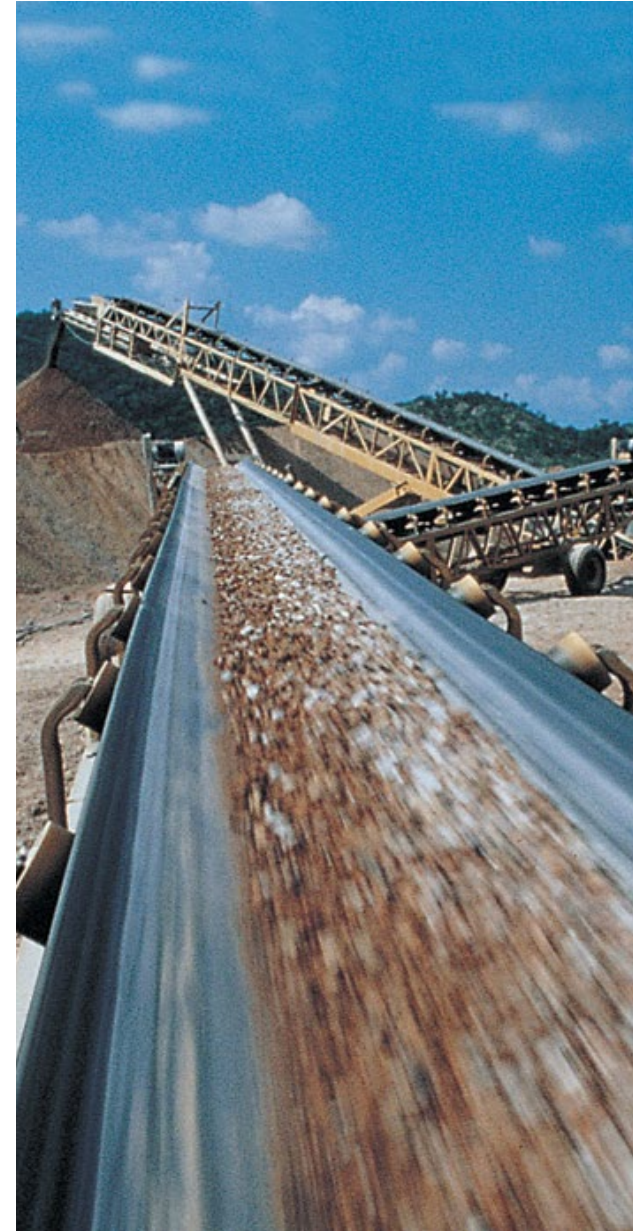
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Feeding process materials

Raw materials quality control

Precise feeding of process materials is critical to maintaining product quality, but measuring and ensuring steel raw material quality control can be challenging.

- Steel mills need belt scales with a range of conveyor speeds and levels of accuracy.
- Weighbelt feeders provide a consistent flow for blending or batching, from light materials at low feed rates to heavy-duty loads requiring faster feeds.
- Online elemental analyzers help monitor and control sintering process fluctuations, inhomogeneous mixtures, and other parameters that affect productivity, physical and metallurgical quality, and raw material consumption and costs.



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Metal gauging

Gauging metal thickness and weight

Metal thickness and coating weight gauges are used in both hot strip and cold-rolling mills. Gauging equipment provides precise, real-time measurements during high-speed production of steel plate and sheet to help you meet the tightest tolerances while maximizing raw material use.

There are **coating weight** gauges to ensure coating uniformity and product quality, **thickness** gauges to help increase productivity, and **profile** gauges to help produce thinner, stronger steels – which also allow in-bar correction of off-gauge product, resulting in raw materials savings and mill optimization.



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Energy efficiency

Furnace efficiency and energy consumption

Process mass spectrometers are widely used in many important gas analysis applications in iron and steel plants, including blast furnace, basic oxygen steelmaking, coke oven gas analysis, secondary steel process control, fuel gas analysis and direct reduction of iron making processes in order to improve furnace efficiency, reduce energy consumption, and maintain compliance with ambient air quality monitoring and reporting requirements.



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Environmental (air & radiation)

Furnace efficiency and energy consumption



Continuous emissions monitoring systems (CEMS)

Comply with regulatory guidelines while meeting your own specific air quality monitoring needs. Thermo Scientific Continuous Emissions Monitoring Systems (CEMS) are designed to meet US EPA 40CFR Parts 60 and 75 standards while providing unsurpassed sensitivity, accuracy and reliability.



Radiation detection portals & monitors

Detect illicit nuclear materials inside packages or cargo at airports, seaports, borders, government buildings, food storage and handling facilities, transportation stations, couriers and freight companies with radiation monitoring devices.

Microalloyed and low carbon steel considerations

Microalloyed steels, or High Strength Low-Alloy steels (HSLA), are strengthened by adding “micro” alloy concentrations to low-carbon mild steel.

Low-carbon steel is used to make clutch housings, bushings and suspension components such as brackets and control arms. Because it improves weldability, low carbon steel is also used in decorative applications such as automotive wheel covers, and as fasteners such as nuts, bolts, screws and washers.



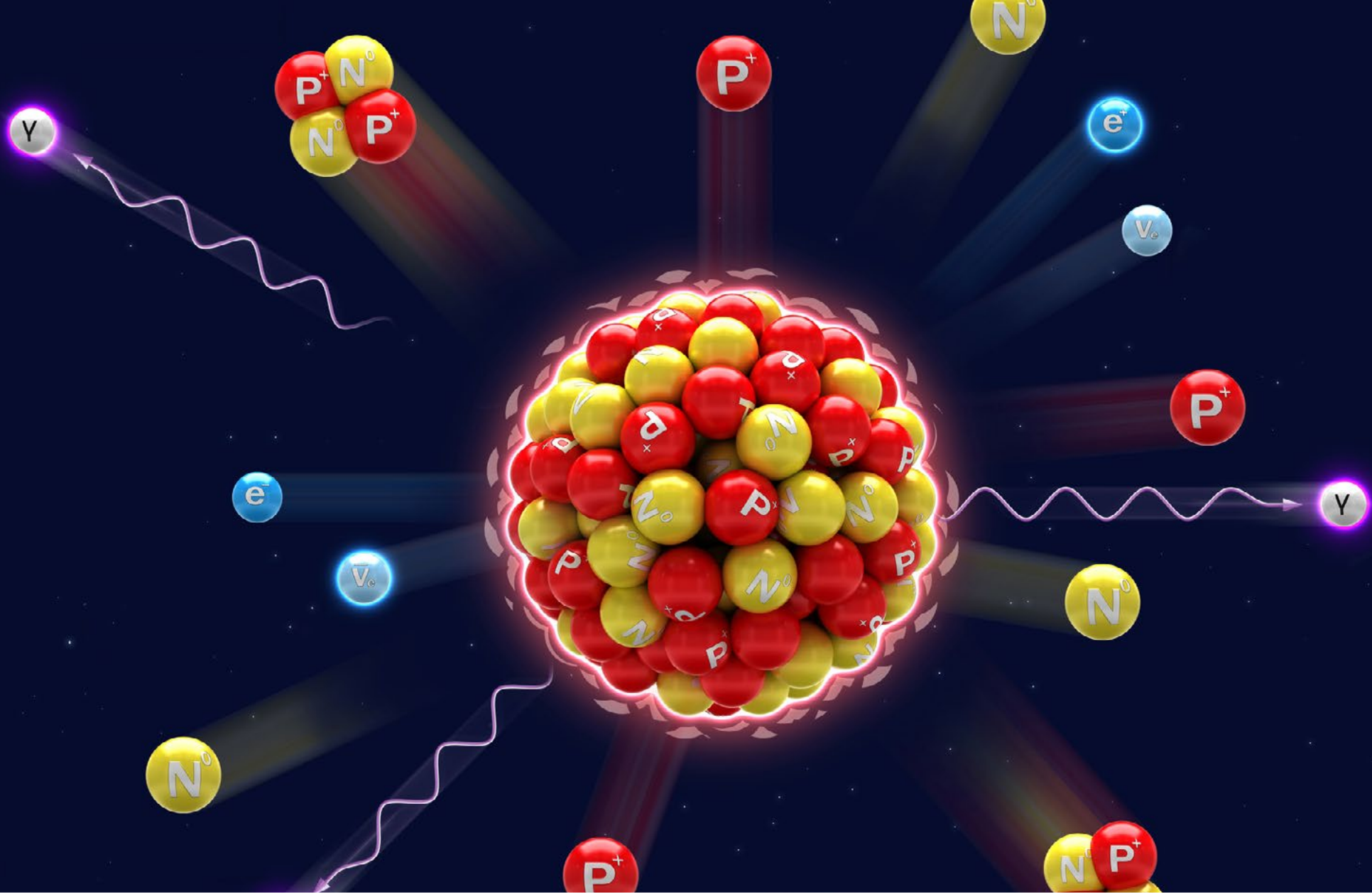
Analysis of microalloying elements in steel

Some handheld XRF analyzers provide excellent trace and micro element precision and sensitivity for microalloyed steel analysis. Given appropriate sample preparation, the analyzer is able to quickly and reliably verify whether the levels of microalloying elements are in agreement with the mill test report and meet the chemical composition requirements per specification.



Improving Low Carbon Steel Production in Specialty Steel Processes

While much of the world's steel is still produced in primary steel processes, the need for steel with greater durability and corrosion resistance has led to the increased use of vacuum degassing processes. Fast and continuous gas analysis of the furnace exhaust gas by process mass spectrometers is important to secondary steel production.



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Technology

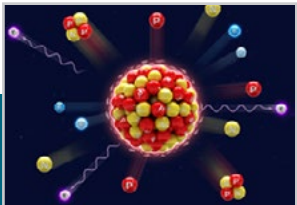
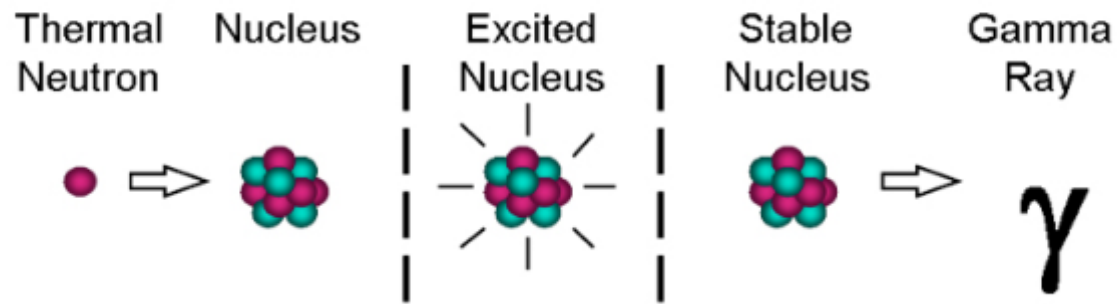
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PGNAA and PFTNA technology

Prompt gamma neutron activation analysis and pulsed fast thermal neutron activation are based on a subatomic reaction between a low energy neutron and the nucleus of an atom. When a thermal, or rather low energy neutron (<0.025 eV) approaches near enough to, or collides with, a nucleus of an atom, an interaction between the neutron and the nucleus takes place. Energy from the neutron is transferred to the nucleus and temporarily elevates it to an excited energy state. The energy is then released, nearly instantaneously, in the form of a gamma ray. The gamma-ray given off has a distinct energy associated with the atom from which it was released. In essence the gamma-ray emitted is like a “fingerprint” of the element. The emitted gamma-rays are detected and an energy spectrum generated which can then be analyzed for elemental composition.



X-ray fluorescence (XRF)

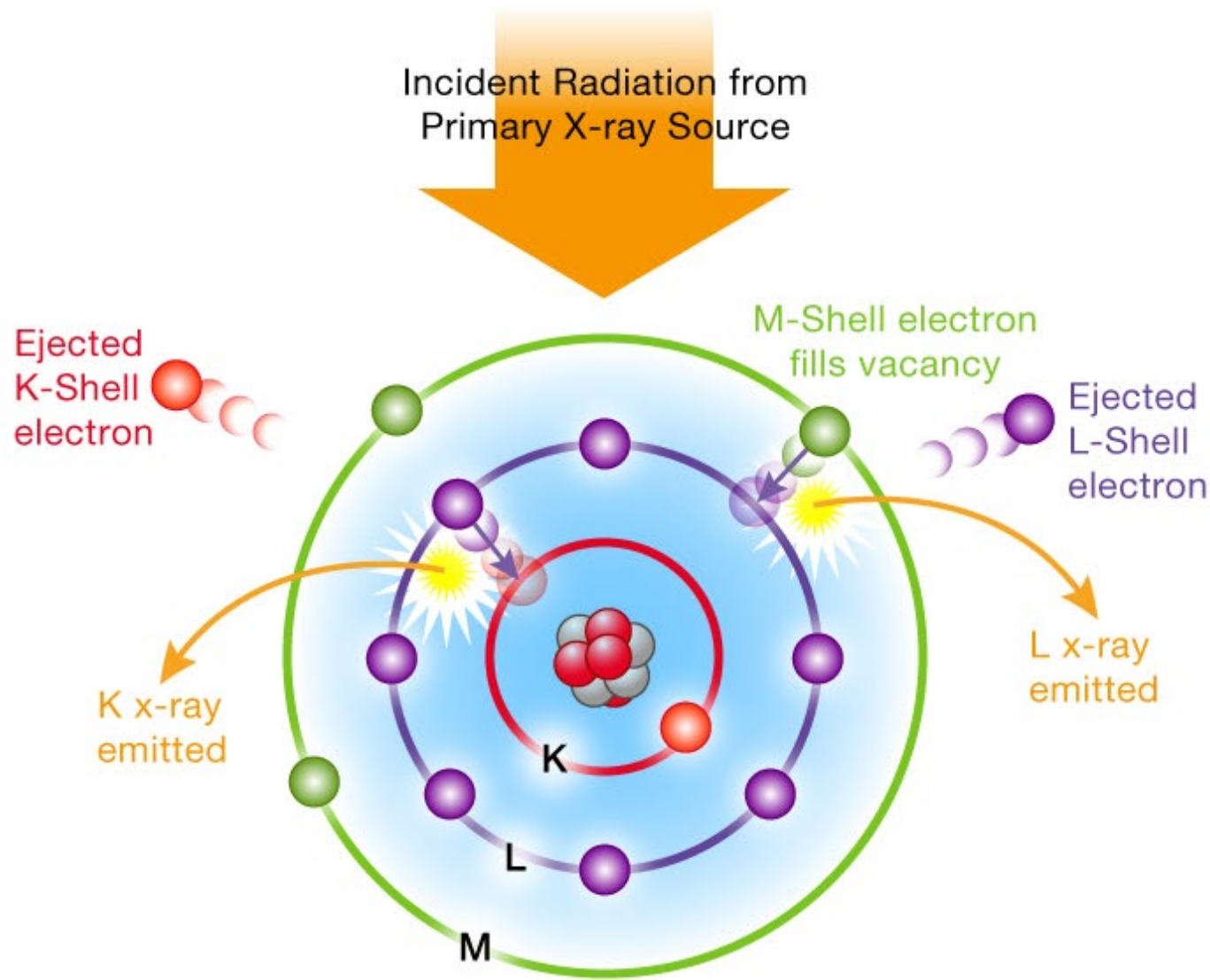
XRF (X-ray fluorescence) is a non-destructive analytical technique used to determine the elemental composition of materials. XRF analyzers determine the chemistry of a sample by measuring the fluorescent (or secondary) X-ray emitted from a sample when it is excited by a primary X-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent X-rays (“a fingerprint”) that is unique for that specific element, which is why XRF spectroscopy is an excellent technology for qualitative and quantitative analysis of material composition.

The X-ray fluorescence process

- A solid or a liquid sample is irradiated with high energy X-rays from a controlled X-ray tube.
- When an atom in the sample is struck with an X-ray of sufficient energy (greater than the atom's K or L shell binding energy), an electron from one of the atom's inner orbital shells is dislodged.
- The atom regains stability, filling the vacancy left in the inner orbital shell with an electron from one of the atom's higher energy orbital shells.
- The electron drops to the lower energy state by releasing a fluorescent X-ray. The energy of this X-ray is equal to the specific difference in energy between two quantum states of the electron. The measurement of this energy is the basis of XRF analysis.

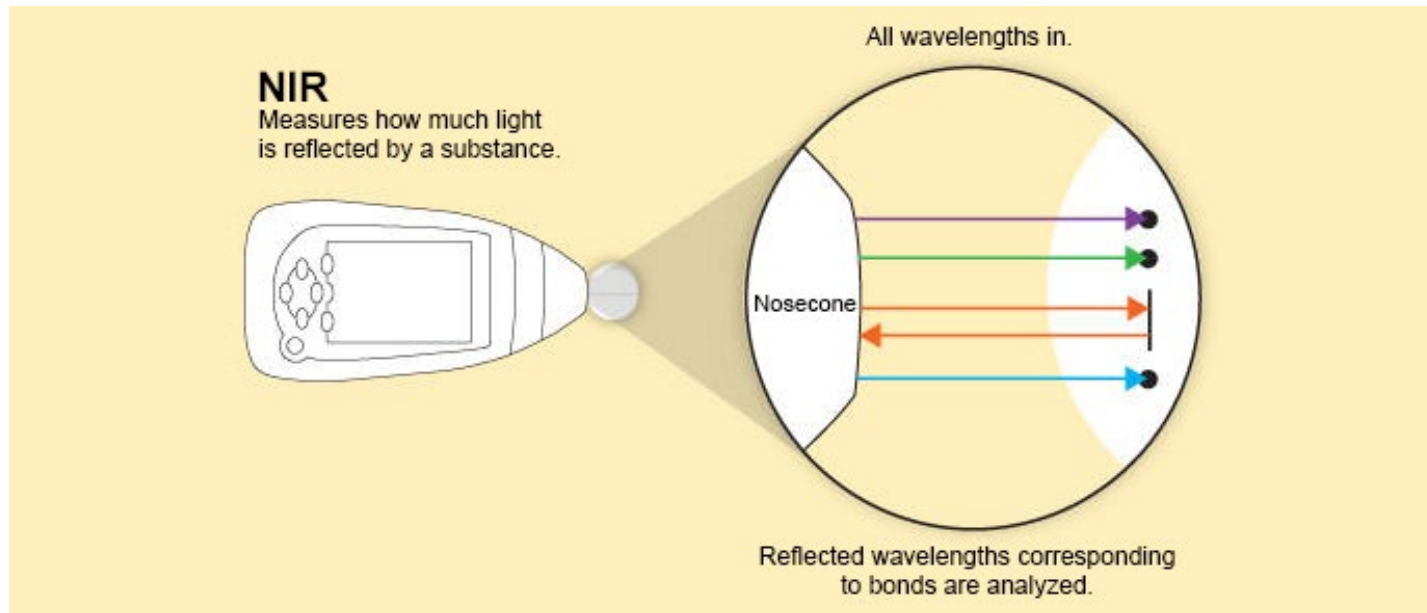


X-ray fluorescence (XRF)



Near-infrared (NIR) spectroscopy

A spectroscopic method that uses the near-infrared region of the electromagnetic spectrum, and is based on overtones and combinations of bond vibrations in molecules.



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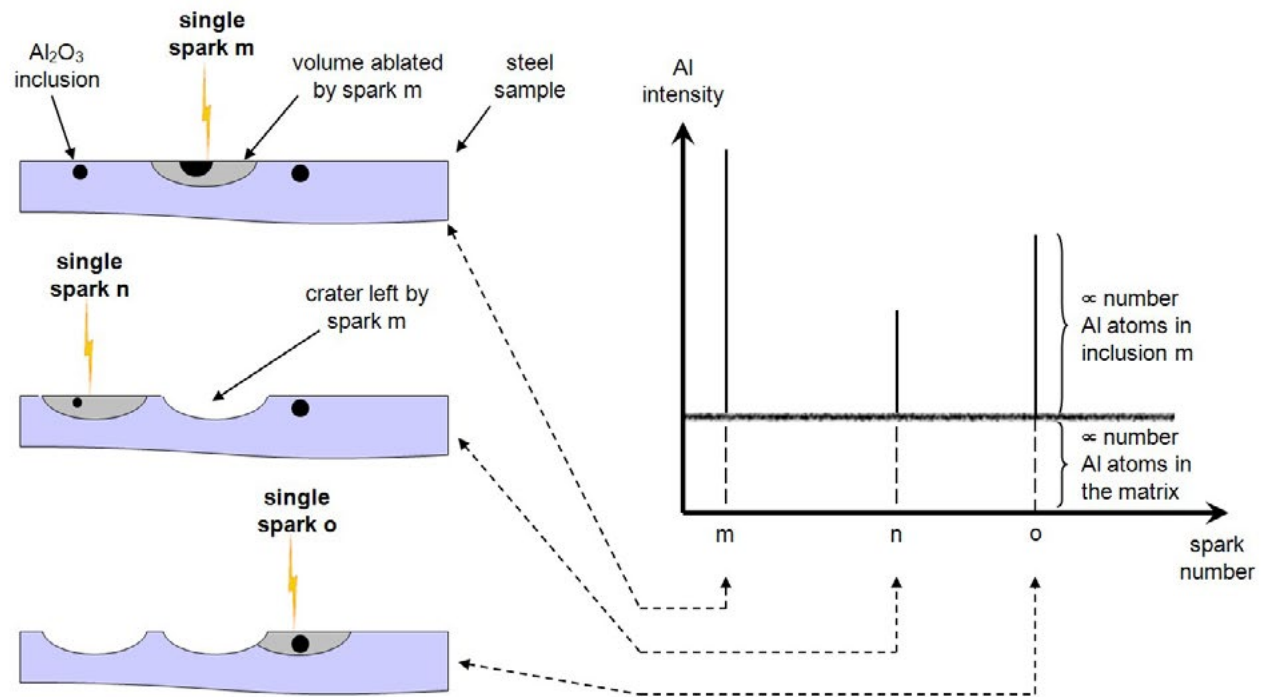


[Click here](#) to learn more about NIR Spectroscopy

Optical emission spectrometry (OES)

OES enables you to perform rapid elemental analysis of solid metallic samples with optical emission spectrometry using Arc/Spark excitation. This technique meets the most demanding analysis needs of the metals industry from production control to R&D, from incoming material inspection to scrap sorting.

Read how [OES provides ultra-fast methods allowing characterization of inclusion during steel production.](#)





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Equipment

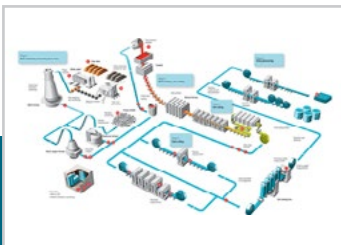
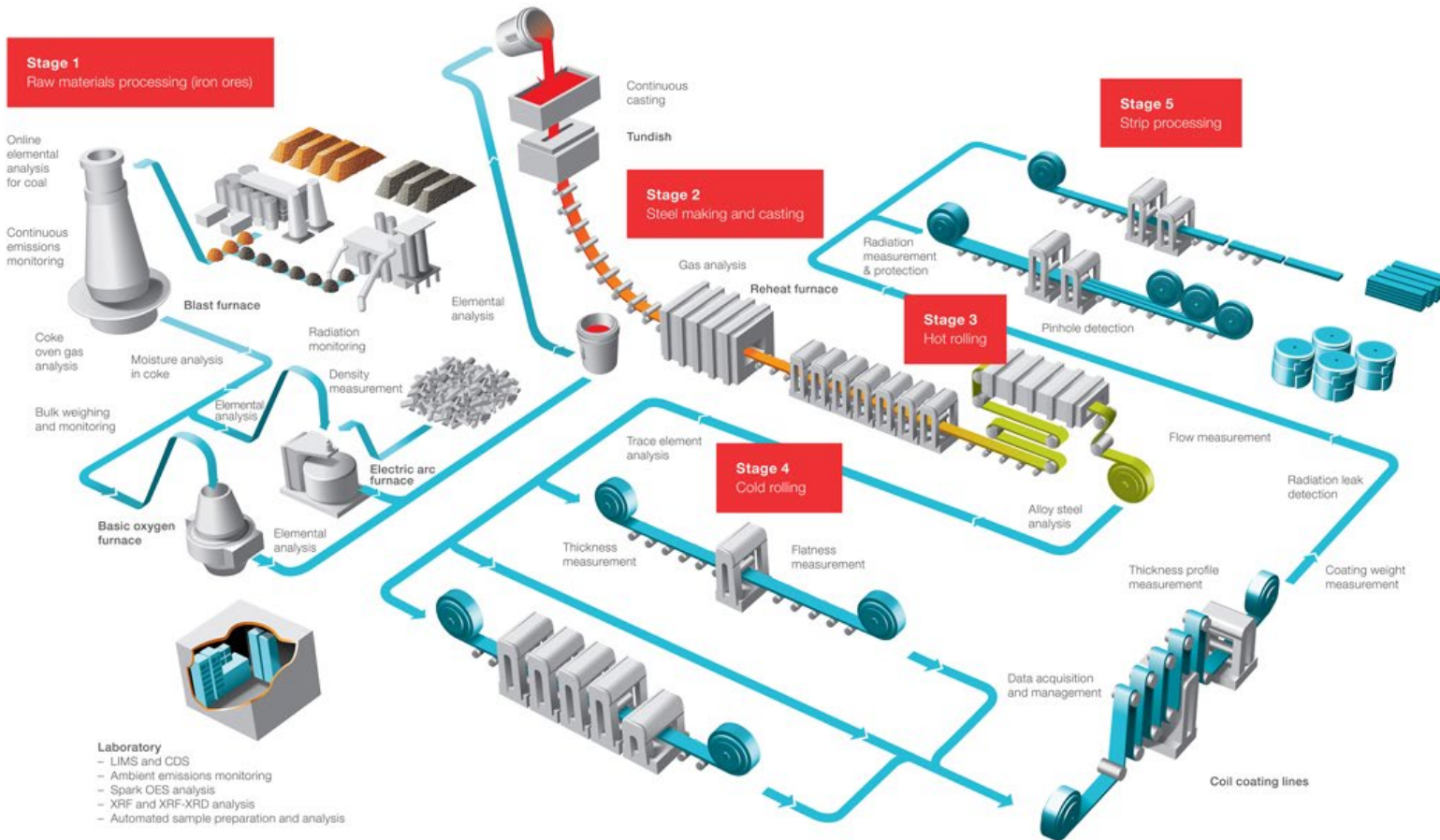


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An overview of products available for the steel making process



[Click here](#) to download the infographic:
The Iron and Steel Manufacturing Process.

Products for monitoring raw materials in steel



CB Omni Fusion Online Elemental Analyzer

The CB Omni analyzer for sinter measures sinter feed chemistry on-line and provides minute by minute, reliable chemical analysis data to enable control of basicity in real time. Gain significant economic benefits for the iron ore sintering process and the blast furnace.

[Product details >](#)



Ramsey Conveyor Belt Scale Systems

Ramsey belt scale systems monitor steel raw material feed to crushers, mills, screens, preparation plants, and coal-fired power plants to help ensure precise feeding of process materials and maintain product quality.

[Product details >](#)



Ramsey Weighbelt Feeders

Accurately control process material feed rates. Weighbelt Feeders help reduce material waste, maintain blend consistency, increase profits, and meet customer specifications.

[Product details >](#)



MOLA/MOLA-LS (Limited Source) Moisture Online Analyzers

Designed for harsh industrial applications, these rugged instruments use patented neutron backscatter, pulse mode, ion chamber technology to non-intrusively measure the moisture content in metallurgical grade coke and/or iron ore pellets.

[Product details >](#)

Products for analyzing trace metals and alloying elements



ARL iSpark Series Optical Emission Spectrometer

Obtain precise spectrochemical analysis of metals for quality control and production in primary metals production, foundries, fabricators in the automotive, aviation and appliance industries, contract laboratories and metal recycling industries.

[Product details ›](#)



Niton XL5 Handheld XRF Analyzer

Handheld XRF analyzers deliver accurate metal and alloy analysis for material verification.

[Product details ›](#)



ARL easySpark Metal Analyzer

Designed for small to mid-size foundries and metals processing companies, or as back-up instrument, this bench top OES analyzer performs fast, accurate and reliable elemental analysis of solid metal samples from trace to percent level.

[Product details ›](#)



ARL 9900 Simultaneous-Sequential XRF Series

Drive process control laboratory efficiencies in iron and steel applications with this complete laboratory workflow automation solution.

[Product details ›](#)



Explorer 4 Analyzer for Industrial Manufacturing

Monitor the quality of incoming material and finished product with improved inclusion analysis and process control.

[Product details ›](#)

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Gauging products for hot and cold rolling processes

Non-contact thickness gauges for aluminum rolling mills



RM 210 AS Aluminum Thickness Gauge

Thermo Scientific non-contact thickness gauges provide reliable, repeatable process control data to ensure product uniformity, and increase output. Get accurate, non-contact thickness measurement of aluminum and aluminum alloys with gauges specially designed for aluminum cold strip and foil mills.

[Product details >](#)

Non-contact metals thickness gauges for hot strip mills



SIPRO Simultaneous Profile Gauge

Thermo Scientific non-contact thickness gauges for hot strip mills provide reliable, high-speed repeatable process control data to identify operating issues, ensure product uniformity, and increase output.

[Product details >](#)

Non-contact thickness gauges for cold rolling and process lines



RM 210 CM Strip Thickness Gauge

Thermo Scientific thickness gauges for cold rolling and process lines provide accurate, non-contact thickness measurement of flat sheet steel in every type of processing line.

[Product details >](#)

On-line non-contact contact thickness gauges

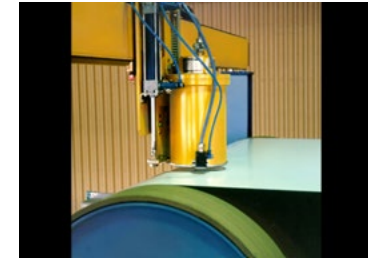


Laser TX Optical Thickness Gauge

Thermo Scientific optical thickness gauges provide accurate on-line non-contact thickness measurements for a variety of sheet processing applications in the steel and aluminum industries.

[Product details >](#)

Non-contact paint thickness gauges



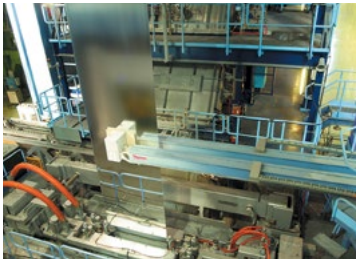
RM 300 EL and PROSIS™ Coating Weight Gauges

Thermo Scientific paint thickness gauges provides fast, accurate and reliable profile measurement of multilayer paint and organic coatings, providing essential information to optimize your production process.

[Product details >](#)

Gauging products for hot and cold rolling processes

Hot coating weight gauges

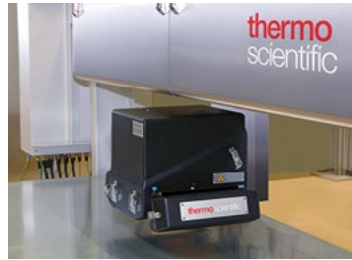


RM 310 EH Hot Coating Weight Gauges

Thermo Scientific hot coating weight gauges significantly improves coating weight control by reducing the dead time between the air knives and measurement, resulting in raw material savings and a reduction in scrap.

[Product details >](#)

Non-contact metallic coating gauges



RM 315 EC Cold Coating Weight Gauges

Thermo Scientific metallic coating gauge provides fast, accurate, non-contact measurement of coatings applied to flat sheet products, helping to ensure coating uniformity, product quality and raw materials savings.

[Product details >](#)

Metals coating weight gauge



Cold Coating Weight Gauges

Thermo Scientific coating weight gauges have employed the physics of x-ray fluorescence to provide accurate and reliable on line measurement of zinc, tin and other metallic coatings.

[Product details >](#)

Basis weight sensor



Beta Plus Basis Weight Sensor

Save raw materials, improve yields, and produce higher quality products with basis weight transmission sensors for extrusion coating, nonwovens, roofing and building products.

[Product details >](#)

Measurement and control system



21PlusHD Measurement and Control System

Thermo Scientific™ 21PlusHD allows manufacturers of coated products or extrusion coated products to maintain the high performance characteristics of critical layers, such as adhesion or barrier layers.

[Product details >](#)

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Improving furnace efficiency and reducing energy consumption



PrimaPRO Process Mass Spectrometer

The combination of fast, accurate MS gas analysis for gas efficiency, heat and mass balances and hydrogen analysis, with advanced process control and mathematical modeling, can reduce coke consumption by up to 100 kg per ton and increase iron production. Process Mass Spectrometers provide fast, accurate, comprehensive gas analysis, enabling integrated steel mills and mini-mills to efficiently monitor primary and secondary conversion methods.

[Product details >](#)



Prima BT Bench Top Mass Spectrometer

Achieve high scanning speeds and reproducible measurements with the Thermo Scientific Prima BT Bench Top Mass Spectrometer. Specifically designed for process development laboratories, this process gas analyzer is a highly precise, multi-port magnetic sector gas analyzer.

[Product details >](#)

Environmental - Air quality monitoring



Ambient Gas Monitoring

We offer a variety of analyzers for the ambient monitoring of the criteria pollutant gases, including CO, NOX, SO2, and others such as CH4 and CO2.

[Product details >](#)



Continuous Emissions Monitoring Systems (CEMS)

Comply with regulatory guidelines while meeting your own specific air quality monitoring needs. These systems are designed to meet US EPA 40CFR Parts 60 and 75 standards while providing unsurpassed sensitivity, accuracy and reliability.

[Product details >](#)

Environmental - Radiation monitoring and soil analysis



ASM IV Series Automatic Scrap Monitoring System

Detect radioactive contamination in scrap metal before it even enters the supply chain with an automatic scrap monitoring system.

[Product details >](#)



Niton XL5 Handheld XRF Analyzer

The Thermo Scientific Niton XL5 Handheld XRF Analyzer enable to measure heavy metal in soils around currently running and former metallurgic plants.

[Product details >](#)



RadEye GR Grapple Monitoring System

This wireless radiation detection system is designed to be installed on a grapple to monitor scrap metal, preventing radioactive contaminated scrap metal from making its way into the steel making process.

[Product details >](#)



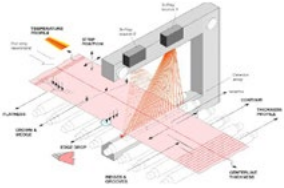
RadEye SPRD Personal Radiation Detector

The pocket-sized Thermo Scientific RadEye SPRD Personal Radiation Detector alerts workers to potential radiation exposure at greater distances without increasing false alarms so they can respond quickly and decisively to real radiation threats.

[Product details >](#)

Additional resources

White Paper

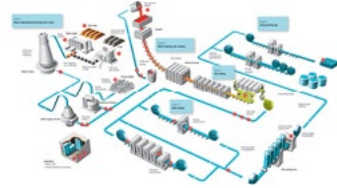


High Speed Archiving of Thickness and Profile Data in the Hot Strip Mill

This paper describes a stereoscopic x-ray profile gauge with the ability to determine both the cross-thickness profile and the physical position of the strip in space.

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Infographic



The Iron and Steel Manufacturing Process

View this process map of the complete range of technologies that improve each stage of the steel manufacturing production process, from incoming raw materials to the final coating line.

[Download >](#)

Application Note



Improving Low Carbon Steel Production in Specialty Steel Processes

The need for refined steel with greater durability and resistance to heat and corrosion has led to the increased use of vacuum degassing processes, such as VOD and RH, in secondary steel production.

[Download >](#)

Application Note



Application of On-line Elemental Analysis for Control of Sinter Feed Basicity

The basicity of sinter feed material is an important parameter in the efficient operation of the sintering and iron making process.

[Download >](#)

Infographic



10 Reasons (and Places) Recyclers Need Radiation Detection

Contaminated scrap metal can result in expensive plant decontamination and shut down. Multiple points of inspection are needed to ensure processed materials are free from radiation.

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