

**SPECTRO**

**AMETEK**  
MATERIALS ANALYSIS DIVISION

# CARBON IN CAST IRON WITH ADVANCED OES TECHNOLOGY

SPECTROMAXx — SPECTROLAB



Excellent performance.  
Unprecedented ease of use.

# Carbon in cast iron

## The Analytical Challenge

Carbon has been the reducing agent used to liberate metallic iron from its ores since the earliest times. A few tenths of one percent difference in carbon content can have a dramatic effect on the mechanical properties of iron and steel, making accurate carbon measurement a critical production issue.

Until the 1980's, the combustion method was the standard technique for determining total carbon levels in iron making. However while highly accurate, this method is a very time consuming and laborious process.

In recent decades, the optical emission spectrometry (OES) method, which uses an electric spark source, became popular. But this method is prone to errors due to the material's granular nature and the presence of free-carbon particles. Until now eliminating these errors depended on perfect sample taking and preparation techniques, that require highly skilled and experienced technicians.



Figure 1: Re-polished sample with pre-spark crater

### OES TECHNOLOGY AND CAST IRON: THE MEASUREMENT PROBLEM

When analyzing granular metals with the OES method, it is normal to use a "pre-spark" or "pre-burn" before the actual measurement. These processes generate thousands of high-energy sparks to melt and homogenize the sample surface before measurement. If free graphite inclusions are present, the pre-spark results in sublimation of some or all of the graphite before the measurement takes place, leading to depressed carbon values. In Figure 1 the small black dots are graphite inclusions. The dark center is due to the fact that in the center the ablation was deeper. However, it is clearly visible that there is a belt around the center without any remaining graphite inclusions. The inclusions are sublimated; bypassing the liquid phase completely.

### Better Technology for Superior Performance

SPECTRO's advanced OES carbon analysis technology excels across the four key requirements for superior carbon measurement performance.

### DIGITALLY CONTROLLED PLASMA GENERATOR

The SPECTROMAXx and SPECTROLAB plasma generators are fully digitally controlled for more accurate and reproducible spark definition. This delivers greater precision, better repeatability, faster measurement, and less impact from external interference.

### GREATER UV PERFORMANCE

The UV optic's atmosphere must be free of water vapor and oxygen to eliminate absorption effects. SPECTROLAB's unique UV-PLUS system contains a hermetically sealed optical chamber that is filled just once with argon. Impurities are removed by a built-in filter cartridge, reducing operating costs and extending maintenance intervals.

# The Solution: Advanced OES technology from SPECTRO

SPECTRO Analytical Instruments has developed an analytical solution that combines the accuracy of the combustion method with the speed and ease-of use of OES. Incorporated in its SPECTROLAB and SPECTROMAXx systems, this advanced OES technology makes it possible to precisely detect and analyze samples containing free graphite with results comparable to those achieved by combustion analysis.

The SPECTROMAXx and the SPECTROLAB instruments can monitor carbon emissions during the pre-spark phase to detect the presence of free graphite and select analytical conditions that minimize its effects. In analysis, the better the quality of the sample, the better the quality of the result; this approach also uses a statistical method to detect bad samples automatically.

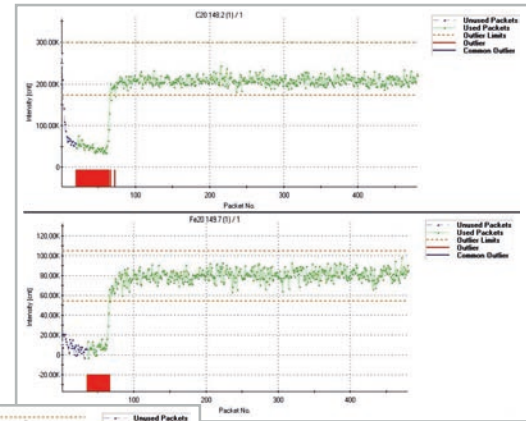


Figure 2: Pre-Spark Intensities - graphite-free sample

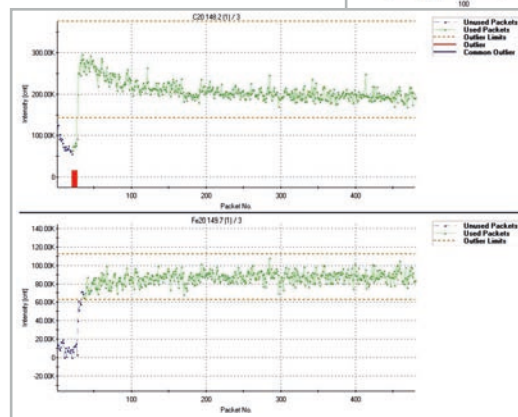


Figure 3: Pre-Spark Intensities - sample containing 0.5% w/w free graphite

Sample	Carbon value measured traditionally	Carbon value determined with the Fe-25 method	Carbon combustion
1a (slowly chilled, <=0.2% graphite)	3.54 %	3.63 %	3.623 %
1b (very slowly chilled >=0.5% graphite, same heat as sample 1a)	3.19 %	3.64 %	3.679 %
<b>Difference between sample 1a and 1b</b>	<b>0.350 %</b>	<b>-0.010 %</b>	<b>-0.056 %</b>
8a (slowly chilled, <=0.2% graphite)	3.58 %	3.66 %	3.589 %
8b (very slowly chilled >=0.5% graphite, same heat as sample 8a)	3.29 %	3.62 %	3.664 %
<b>Difference between sample 8a and 8b</b>	<b>0.290 %</b>	<b>0.040 %</b>	<b>-0.075 %</b>
16a (slowly chilled, <=0.2% graphite)	3.52 %	3.69 %	3.599 %
16b (grey >=0.5% graphite, same heat as sample 16a)	3.15 %	3.68 %	3.666 %
<b>Difference between sample 16a and 16b</b>	<b>0.370 %</b>	<b>0.010 %</b>	<b>-0.067 %</b>

## COMPARISON OF RESULTS

The table compares carbon results measured with traditional, combustion, and new Fe-25 methods.

## SOPHISTICATED DATA PROCESSING

The SPECTROLAB and SPECTROMAXx produce data that enables the coverage of the spectrum relevant for iron analysis. In addition to the output of results for individual elements, the data can be sorted according to measurement, configuration, or readout of the wavelength scan.

## HIGHER OPTICAL RESOLUTION

The SPECTROMAXx is equipped exclusively with CCDs. For those requiring minimal trace analysis and time-dependent spark examination, the SPECTROLAB offers either the advanced CMOS+T technology or a combination of CCDs and PMTs in a single, powerful instrument.



# SPECTROMAXx & SPECTROLAB Sophisticated Technology



## SPECTROMAXx

The SPECTROMAXx offers a perfect combination of robust hardware and simply easy operation. Covering the wavelength range from 146nm to 780nm, fixed methods, including element selection and calibration ranges for a total of 10 different matrices, are available.

<https://www.spectro.com/maxx>

## SPECTROLAB

Both the CMOS+T and the third-generation hybrid SPECTROLAB models offer excellent optical performance for metals industry applications, i.e. low detection limits, super fast analysis time, ultimate elemental flexibility and spectacular stability.

Focal length for both models is 750 mm, covering the wavelength range from 120 nm to 770 nm for the SPECTROLAB S and 120 nm to 560 nm (optional to 766 nm) for the Hybrid model.

<https://www.spectro.com/lab>

## COMPLETE LINE OF METAL ANALYZERS

SPECTROMAXx stands beside SPECTRO's flagship SPECTROLAB, a market leader for ultra-precise analysis, plus the entry-level SPECTROCHECK, offering high performance and dependability at a very competitive low price. It's complemented as well by SPECTRO's mobile product line, with the SPECTROTEST mobile analyzer, the SPECTRO xSORT XRF handheld analyzer, and the SPECTROPORT portable metal analyzer.

SPECTRO's unparalleled record of technological innovation ensures that users always get the best results in the business with every instrument.



## SUPERIOR SERVICE AND SUPPORT

For metal producers, productivity depends on continued availability of analysis. The AMECARE Performance Services program maximizes uptime for SPECTROLAB, SPECTROMAXx and other SPECTRO Analytical products.

The program is staffed by more than 200 experienced service engineers in 50 countries. They provide high-value, customized services designed to ensure optimum performance plus the longest possible equipment life. Ask about AMECARE proactive performance maintenance, performance upgrades, applications solutions, consultation, targeted training, and ongoing support.

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