



Background

Positive Material Identification (PMI) inspection sometimes requires the testing of in-service components that are at high temperatures, such as pipes, reaction vessels, etc.

Not only do the environmental conditions present a challenge for both the user and the instrumentation, the alloys tested also often contain elements at trace levels (e.g. Si, Mn, Cr, Cu).

This means that the test equipment used for alloy verification must be fast, rugged and provide the best level of performance even in these harsh conditions.

Recent developments in handheld X-ray fluorescence (HHXRF) spectrometry have enabled us to meet some of these challenges.

X-MET8000 Series handheld analysers

Oxford Instruments' latest generation of field portable analysers present many advantages for on-site materials verification:

- The optimised combination of a high performance X-ray tube and Oxford Instruments' large area silicon drift detector (SDD) delivers the speed and performance needed for the measurement of trace alloying elements
- Rugged: its IP54 rating ensures durability and low cost of ownership. Ideal for outdoors use

- The **X-MET**'s large heat sink provides the most efficient heat dissipation, ensuring stability and reliability, even in hot environments
- Compact and lightweight (1.5kg with battery), the **X-MET8000** is fully portable, for true on-site analysis.

Oxford Instruments' unique solution for reliable hot sample analysis: new HERO™ (heat resistant) window

Oxford Instruments has designed a brand new protective analysis window which allows hot samples of up to 400°C to be directly analysed for alloying elements, including light elements such as silicon!

When testing hot samples, all the user has to do is to swap the normal Prolene window for the HERO™ window! It couldn't be simpler. There is no need for special spacers, shields, or tilting techniques which might have a detrimental effect on the results accuracy, especially for light elements.



Easy-swap window: no tool needed

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Sample preparation

To ensure accurate results, the surface of the tested parts should be cleaned. To remove paint, corrosion, and dirt, it is recommended to use an angle grinder fitted with a zirconium sand disk.

Hot samples bring additional challenges: their surface oxidises very rapidly, therefore it is recommended to measure the ground surface quickly. Also, the structure of a hot alloy sample differs from that of the same alloy when cold, so you are likely to see differences in composition if measuring the same alloy hot or cold.

Measurement procedure

For optimum reliability in high temperature conditions, it is important to operate the **X-MET8000** (fitted with a HERO window) as shown in Graph 1.

For example, if measuring a piece at 200°C, the maximum measurement time that can be used is 20 seconds. If measuring for 20 seconds, then the minimum cool-off time between analyses is 3 minutes; if measuring for 10 seconds, the cool-off time decreases to 1.5 minute (90 seconds).

As a simple rule, the higher the temperature, the shorter the measurement time, and the longer the cool-off time.

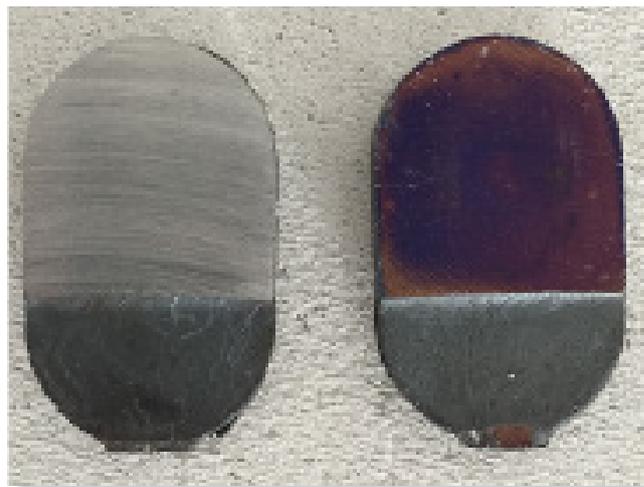
Performance

The **X-MET8000** Expert fitted with the HERO window was used to test both accuracy and precision for samples at various temperatures. A series of reference low alloy steel samples were analysed at room temperature (22°C), then heated up in a furnace and tested at 200, 350 and 400°C using the Alloy mode (standardless FP analysis, including light elements).

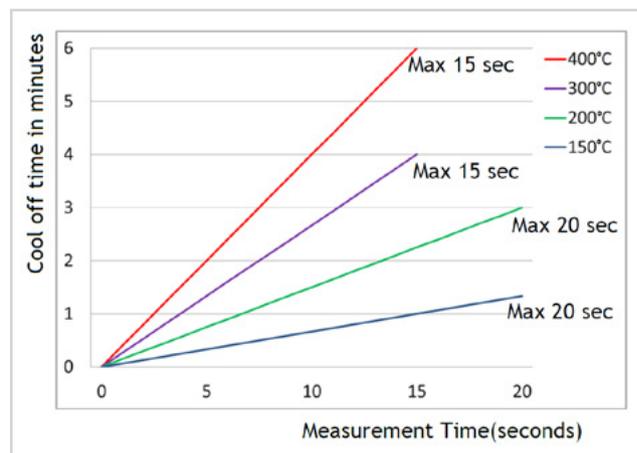
Note: the samples' surfaces were not ground before analysis to ensure they would not cool down before testing. However the severe oxidation on the surface of the heated samples had a noticeable effect on the silicon (Si) results, which increased with temperature and oxidation levels (see tables 1 and 2).

The samples were analysed for 20 seconds at room temperature and at 200°C, and for 15 seconds at 350 and 400°C. The analyser was left at room temperature for 6 minutes to cool down between readings.

Tables 1 and 2 show the analysis results for two standards.



Steel lollipop: ground (left), then heated to 350°C (right).



Graph 1: Measurement procedure for hot samples at different temperatures

Table 1: X-MET8000 results for Standard 1 at various temperatures

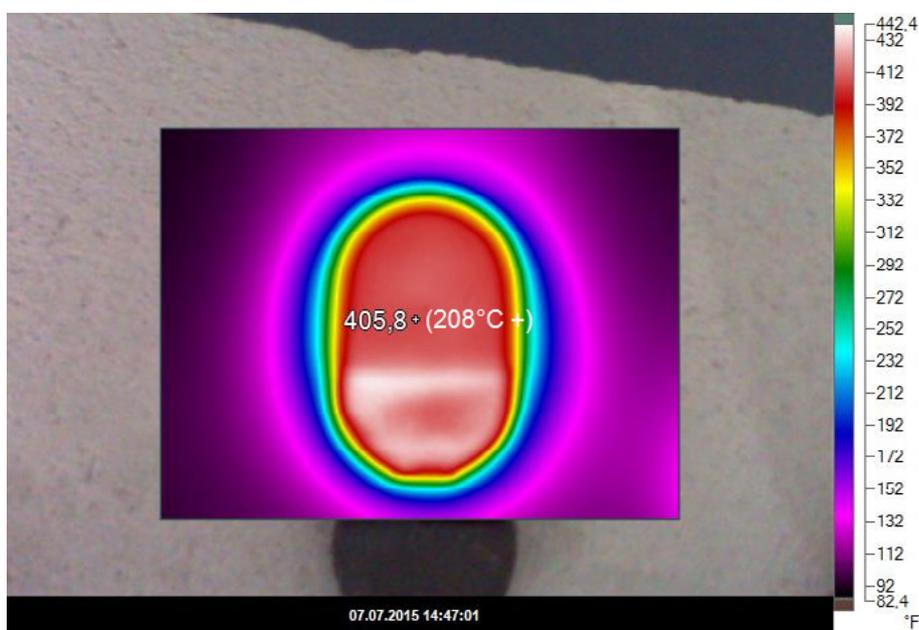
Sample temperature (measurement time)	Si, %	Cr, %	Mn, %	Ni, %	Cu, %	Mo, %
22°C (20s)	0.80	1.33	1.42	0.28	0.05	0.029
200°C (20s)	0.94	1.32	1.49	0.25	0.05	0.029
350°C (15s)	1.11	1.32	1.42	0.29	0.02	0.028
400°C (15s)	1.28	1.33	1.44	0.26	0.03	0.026
Given content	0.74	1.31	1.50	0.32	0.09	0.030

Table 2: X-MET8000 results for Standard 2 at various temperatures

Sample temperature (measurement time)	Si, %	Cr, %	Mn, %	Ni, %	Cu, %	Mo, %
22°C (20s)	0.20	0.71	0.66	1.90	Not detected (ND)	0.21
200°C (20s)	0.33	0.73	0.59	1.90	ND	0.21
350°C (15s)	0.53	0.69	0.61	1.85	ND	0.20
400°C (15s)	0.74	0.70	0.63	1.91	ND	0.20
Given content	0.23	0.69	0.67	2.00	0.042	0.19

The results show that the content of alloying elements can be determined reliably, even at high temperatures and short measurement times.

The Si results vary because of the change in the sample surface. This remains the main challenge in the testing of hot samples, as the oxidation process is fast at very high temperatures.



Infrared image of a heated steel lollipop

Summary

The **X-MET8000** handheld analyser provides rapid and reliable material identification and chemistry for positive material identification (PMI) inspection as well as for manufacturing quality assurance. With Oxford Instruments' unique HERO window, the **X-MET** can be used to test hot samples up to 400°C, allowing users to carry out in-service testing, and minimising downtime.

Ordering Information

- **X-MET8000 Optimum or Expert.** Includes the compact, waterproof, rugged carrying case, a wrist strap and lanyard, 2 batteries, a battery charger, a USB cable to connect to a PC/laptop, 5 replacements windows, and the user manuals
- **HERO** window set (P/No. 54-4106384 for a set of 2)
- Optional: holster and belt (P/No. 54-4106296) for hands-free operation
- Optional: 1, 2 or 3 year extended warranty



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