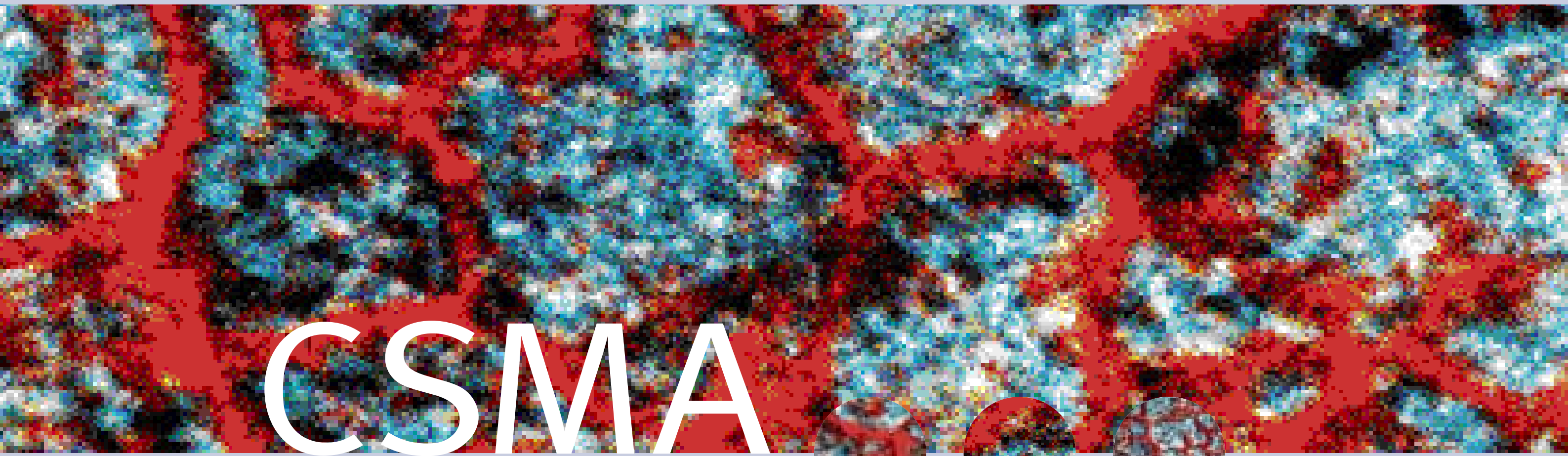
TOTAL SOLUTIONS FOR
THE METALLURGY INDUSTRY



CSMA

The field of metallurgy utilises an ever-increasing array of steel and alloy compositions in addition to a large number of processing techniques employed in material production through to product finishing. Surface analysis plays a key role in the characterisation of these materials, from their microstructure to large scale customer complaints. The high sensitivity of techniques such as Secondary Ion Mass Spectrometry (SIMS) can be invaluable in establishing the material chemistry, particularly for low level additives, impurities or contaminants.

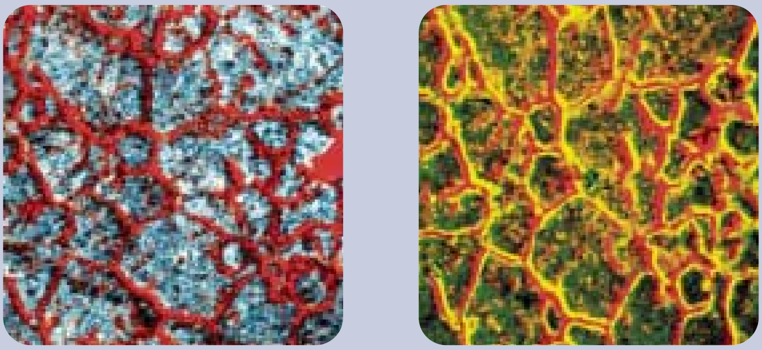
BENEFITS TO CUSTOMER

- Location of ppm/ppb levels of elements in microstructure.
- Clear and precise determination of the cause of corrosion.
- Potential detection of corrosion products before the appearance of visual evidence.
- Detection of low levels of corrosion accelerators such as chlorine.

CASE STUDY ONE

Microstructure of Treated Steel

An example of the use of SIMS to reveal microstructure can be seen in the images of boron, hydrogen, carbon nitride and iron obtained from a boron doped (50ppm) stainless steel sample, heat treated at 1070°C in a dissociated NH_3 atmosphere. The heat treatment causes the formation of an almost uniform layer of boron nitride at the stainless steel surface which also extends for some distance into the bulk. SIMS imaging discloses the localisation of hydrogen and CN- containing compounds at grain boundaries with ppm sensitivities.



SIMS images of treated stainless steel showing H^+ (red), B^+ (cyan) (left) and CN^- (red), Fe^- (green) [right]. Field of view 100µm.

CASE STUDY TWO

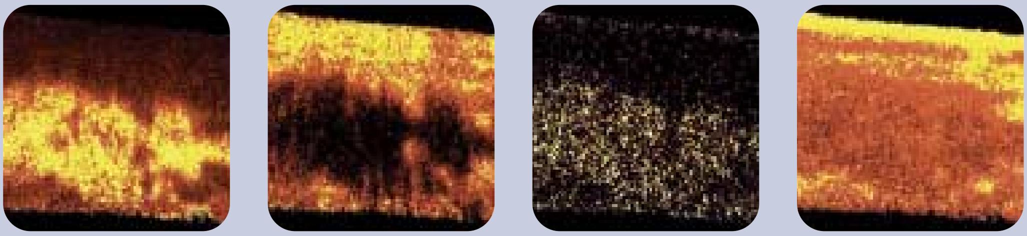
Corrosion Problems on Steel Wires

Localised corrosion had appeared on reels of wire after long term storage but investigations by the manufacturer had shown no correlation between the problem and the materials used. These included steel, drawing lubricants and post-drawing, lanolin protective coating.
XPS compositional analysis (below) of corroded and uncorroded areas, at CSMA, shows a significantly higher concentration of iron in the corroded areas coupled with lower levels of calcium and sodium from the drawing lubricants (a mixture of calcium and sodium stearates).

XPS SURFACE COMPOSITIONS (FIGURES IN ATOMIC%)

Analysis Area	Carbon	Oxygen	Iron	Calcium	Chlorine	Sodium	Sulphur
Corroded	35.4 ±1.2	50.8 ±1.1	8.1 ±0.4	3.5 ±0.3	0.9 ±0.4	1.3 ±0.5	-
Uncorroded	38.9 ±0.8	46.0 ±0.7	4.3 ±0.2	6.2 ±0.2	0.5 ±0.2	3.4 ±0.4	0.7 ±0.4

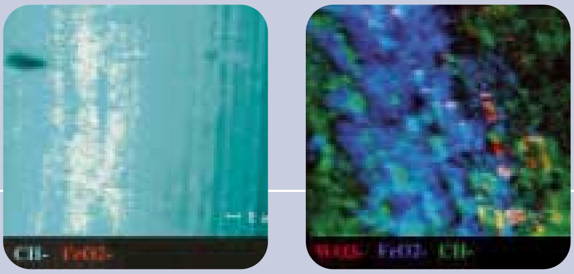
XPS images of a corroded area show an exposed iron area (rust) covering the lower part of the wire. The corrosion areas are associated with striations along the wire in the drawing direction. Surrounding areas are rich in carbon, calcium and sodium residues from the drawing lubricants. The chlorine distribution correlates with iron suggesting an association between the two.



Iron Calcium Chlorine Carbon

XPS images of corroded wire (analysis area 1.6 x 1.2 mm, resolution 10 -15 µm

SIMS imaging analysis (below) showed that all corrosion areas contain tungsten (as tungsten oxide), as a result of the break-up of the wire-drawing dies during processing.
The combination of XPS and SIMS analysis proved that corrosion arises as a direct result of a reduced level of lubricant during wire drawing which also causes the break up of the drawing dies. The reduced level of organic material and the roughening of the surface leaves the steel exposed to attack by classical aqueous corrosion, accelerated by the presence of chlorine.



SIMS images of drawn wires showing uncorroded wire [left] (CH^- cyan, FeO_2^- red) and corroded wire [right] (WO_3^- red, FeO_2^- blue, CH^- green).
Field of view is ~300 µm.

CSMA provides a complete surface analysis service to industry to accommodate every level of demand:

- rapid turnaround analysis (24 hours)
- problem solving and failure analysis
- litigation and expert witnesses
- training courses
- reverse engineering and competitor analysis
- materials and product development
- patent registration / infringement

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