Investigation of Stainless Steel Strip Laser Welding Problems – Solved Using Auger Electron Spectroscopy Depth Profiling

Production Process Problem

The object of this work was to determine the reasons why in a continuously fed reel of 1.5mm wide stainless steel strip there were process yield problems in a laser welding component assembly operation. Production operator observations suggested this might be linked to a subtle yellow surface discolouration seen periodically along the length of the strip. The strip had been thermally reduced to ensure the correct mechanical properties in the later cropping process as well as over the component's functional life.

Analytical Technique Capabilities

Auger Electron Spectroscopy (AES) is an analytical technique which determines the chemistry of the top few nm of metals and materials. An inert gas ion beam can be used in conjunction with AES to controllably etch away the surface of the material to reveal the subsurface and ultimately produce a chemical depth profile.

Auger depth profiling was used to examine small samples of good and bad areas (determined by the yellow discolouration) of the stainless steel strip.

Surface Analytical Results

Yellow Discoloured Area – Weld ability Poor

Normal - Easy to Weld Material

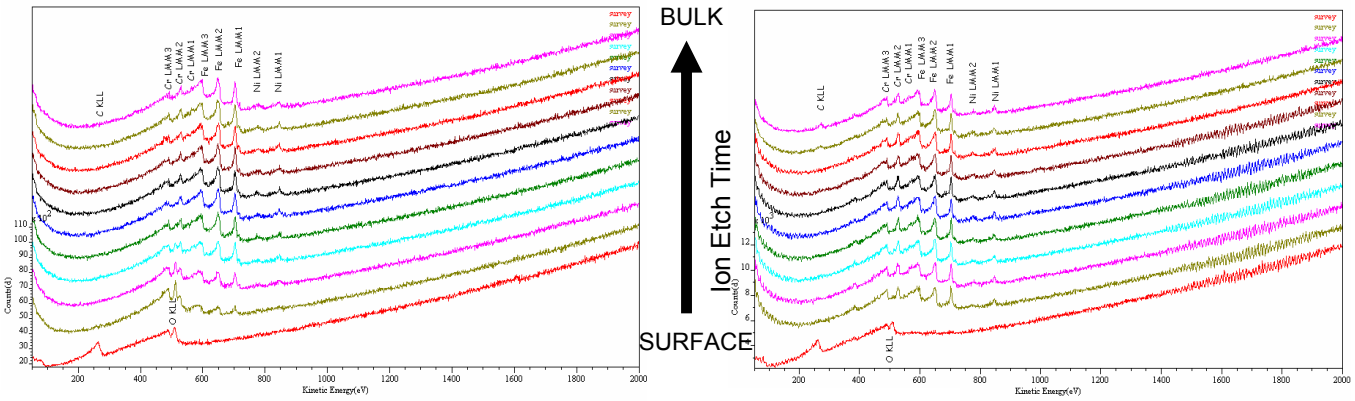

Fig.1. Auger Electron Spectroscopy depth profile montage spectra of 2 stainless steel samples. The yellow discoloured area of the strip proved very difficult to laser weld compared to normal material.

Auger Depth profiles can be constructed by measuring the areas under each peak at every stage of ion etching. These areas are proportional to the atomic concentration of the elements present using the appropriate relative sensitivity factors. From profiles it is possible to reconstruct the surface structure of the material as shown overleaf.

(* denotes UKAS accredited test)

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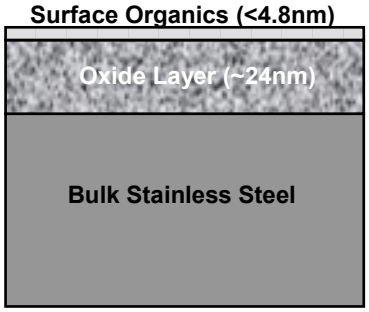

Fig.2. Schematic of the surface structure revealed by sputter depth profiling in Fig.3.. The surface oxide is surprisingly thick for a stainless steel, particularly since the material had just been furnace reduced.

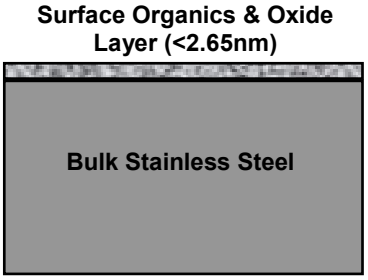

Fig.4. Schematic of the surface structure revealed by sputter depth profiling in Fig.5. The surface oxide on the stainless steel is much thinner than in the yellow discoloured areas.

Process Problem Solution

Auger electron spectroscopy and depth profiling has shown that the subtle yellow discolouration on certain parts of the reel strip was due to excessive surface oxidation of the stainless steel. This oxide layer made weak welds as it was interfering with the laser welding process.

Careful optical inspection of the strip showed there was a consistent spacing between discolourations and the damage was always close to one end of the spool. As the spools of wire were continuously fed through a tube furnace it was possible to match this to gas burn-off points at either end of the hot zone. A low level of ingress of air at these points caused the oxidation and this was made significantly worse as the production tool stopped periodically awaiting a spool change.

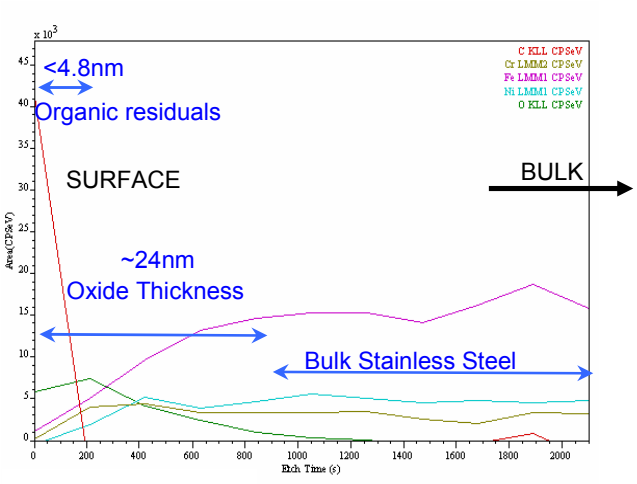

Fig.3. Quantified Auger depth profile of yellow discoloured area with poor weld-ability- Etch rate = 1.36nm/min

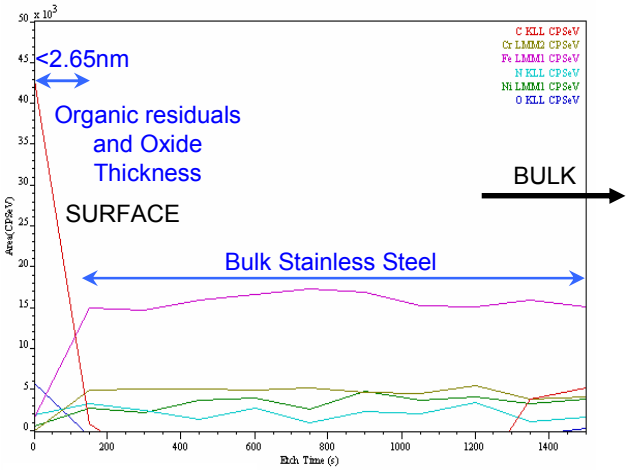

Fig.5. Quantified Auger Depth profile of Normal Easy-to-Weld Material– Etch rate = 1.06nm/min

The problem at the downstream laser welding process could be solved by quick removal of the finished spool or more reliably by preventative scrapping the extreme ends of the spool following the furnace treatment.

Contact us today

Find out how we can help solve your problems in process improvement, process control and materials analysis

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