Technical Service Report

Customer: Ensitech

Location: Old Bathurst Rd., Emu Heights, NSW

Reported by: Simon Lewer

Control number: GIE-E-009

Date: 24th November 2009

Work Requested: SEM of 316 stainless steel after a variety of treatments as follows:

A) Not welded or cleaned
B) TIG welded only
C) TIG welded followed by cleaning with TIG Brush using TB-20
D) TIG welded followed by cleaning with TIG Brush using TB-25
E) TIG welded followed by cleaning with TIG Brush using TB-30ND
F) TIG welded followed by cleaning with pickling paste

Sydney Office
10 Victory Ave.
Camden, NSW, 2570

0404951681
simonlewer@gauge.com.au

Brisbane Office
1 St. Clair Cl.
Parkinson, Qld. 4115

ph: 07-3711 2080
fax: 07-3272 4581
admin@gauge.com.au

Method

From the one panel of 316 stainless steel that had a series of TIG welds made as strips, 3cm sections were cut with the weld strip through the centre of section. A section of unwelded, unmarked stainless steel was cut from the same panel to be used as a blank showing the elemental composition of the stainless steel prior to welding. This was labelled Sample A.
One of the welded sections was not cleaned, labelled Sample B and provided a negative control for this study. All other sections were individually cleaned with a range of cleaning techniques followed by a tap water rinse and wiped with a separate clean cloth.
All samples were analysed via a Scanning Electron Microscope (SEM) for the major elements detected on the sample surface. For the welded samples, the SEM examined surface was the weld line.

The sample descriptions are below:

Sample	Sample Description
A	Unwelded 316 stainless steel
B	TIG welded 316 stainless steel
C	TIG welded 316 stainless steel then TIG Brushed with TB-20
D	TIG welded 316 stainless steel then TIG Brushed with TB-25
E	TIG welded 316 stainless steel then TIG Brushed with TB-30ND
F	TIG welded 316 stainless steel then cleaned with pickling paste

All samples were scanned via the microscope using the “average of an area” format of analysis. This is not a single point analysis but scans hundreds of points in an area of approximately 2 mm^2 to build a more accurate assessment of the sample. The SEM result for each sample presented in this report is the average of the analysis of these hundreds of points.

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Results

Sample	Sample Description	Fe (%)	Cr (%)	Ni (%)	O (%)	Si (%)	Na (%)	Al (%)	S (%)	P (%)	Mo (%)	Ca (%)	K (%)
A	Unwelded 316 stainless steel	72.36	20.59	7.04	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
B	TIG welded 316 stainless steel	49.98	17.69	7.77	10.38	1.8	4.64	1.01	3.29	1.01	BDL	0.45	1.97
C	TIG welded 316 stainless steel then TIG Brushed with TB-20	69.28	20.42	9.14	BDL	0.66	BDL	BDL	0.49	BDL	BDL	BDL	BDL
D	TIG welded 316 stainless steel then TIG Brushed with TB-25	67.81	20.97	9.22	BDL	1.19	BDL	BDL	0.81	BDL	BDL	BDL	BDL
E	TIG welded 316 stainless steel then TIG Brushed with TB-30ND	67.97	20.71	9.76	BDL	BDL	BDL	0.3	BDL	0.51	BDL	BDL	BDL
F	TIG welded 316 stainless steel then cleaned with pickling paste	68.82	20.22	9.26	BDL	0.69	BDL	BDL	BDL	BDL	1.01	BDL	BDL

BDL= Below Detectable Limits

Interpretation

The findings show:

1. That TIG welding results in a large oxide component as shown by the high oxygen levels before cleaning in this study.
2. The large amounts of Si, Na, Al, S, P, C and K in Sample B which are due to the flux in the welding wire.
3. The TIG Brushing and pickling paste removed all detectable oxides from the weld which supports the theory that TIG Brushing and pickling paste passivate the welded surface.
4. The TIG Brushing and pickling paste returned the approx. 20.6 % Cr levels which were found in the unwelded sample A.
5. That the TIG Brush using TB-20, TB-25 or TB-30ND was effective in oxide removal to undetectable levels
6. Whilst it needs explanation of significance, TIG Brushing with TB-30ND was the only treatment that removed all Si left on the weld after the welding process.

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7. All TIG Brushing and also pickling paste increased the Ni % in the steel from 7.0% in the unwelded sample to between 9.2-9.8%. This increase needs further investigation and explanation.
8. TIG Brushing with TB-20 presented very comparable results to pickling paste. Apart from the Si reduction, TIG Brushing with TB-30ND also gave very comparable results to pickling paste.

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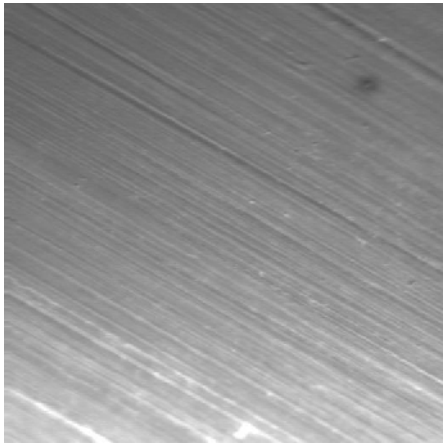
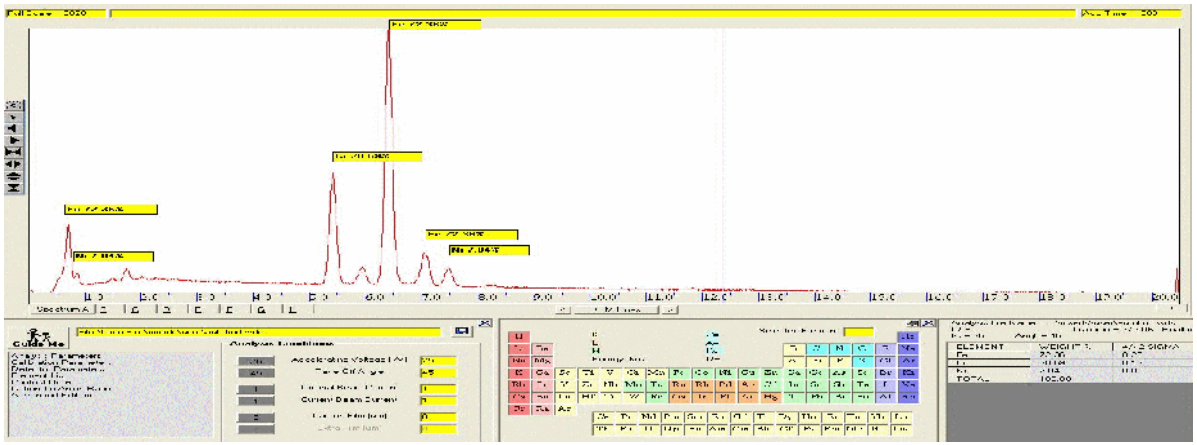
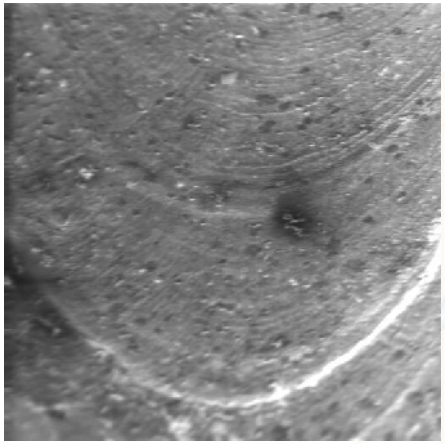
Appendix- Scanning Electron Micrographs with images.

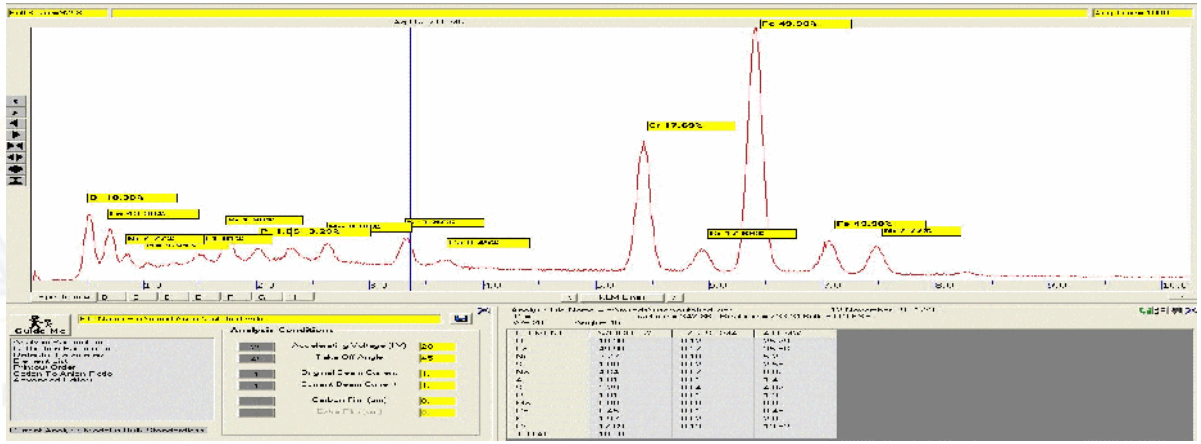
Sample A





Sample B





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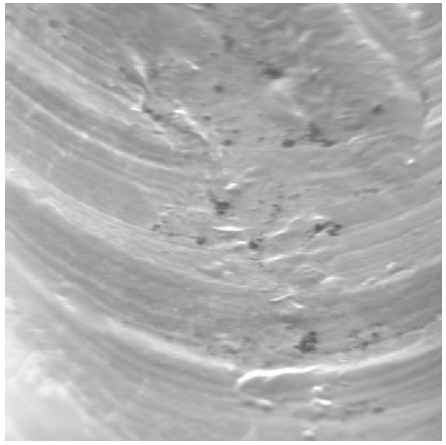
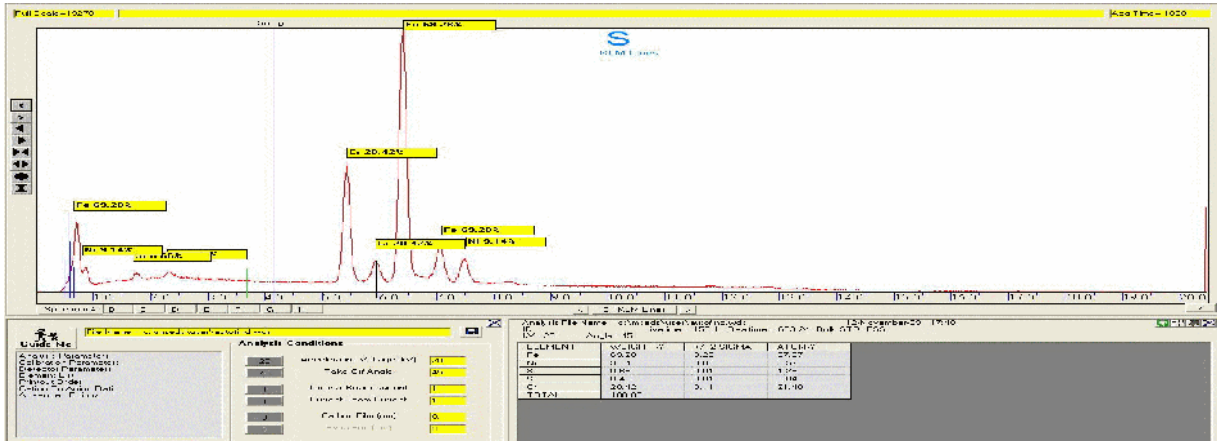
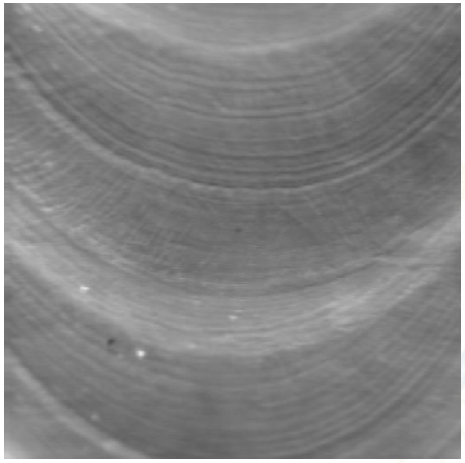
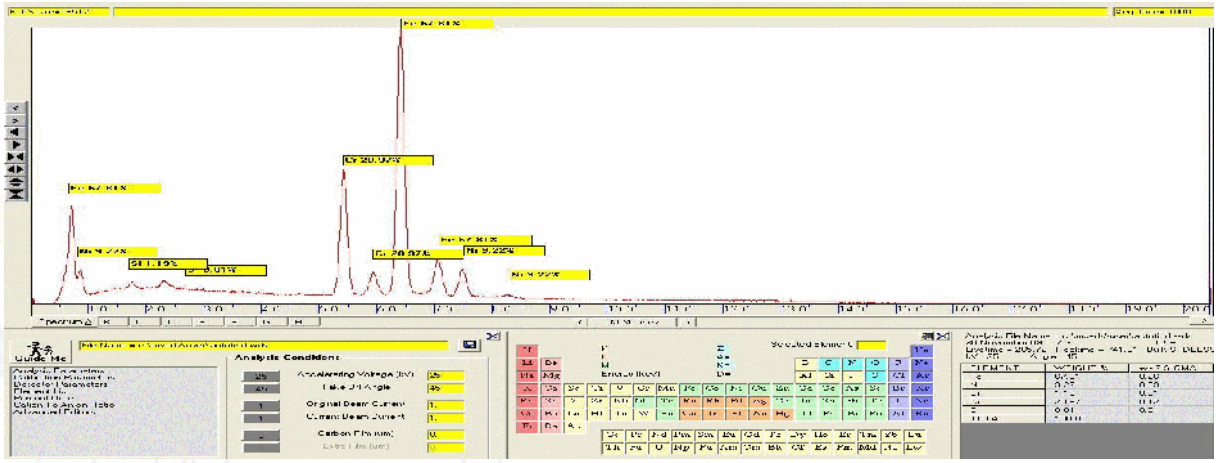
Sample C





Sample D





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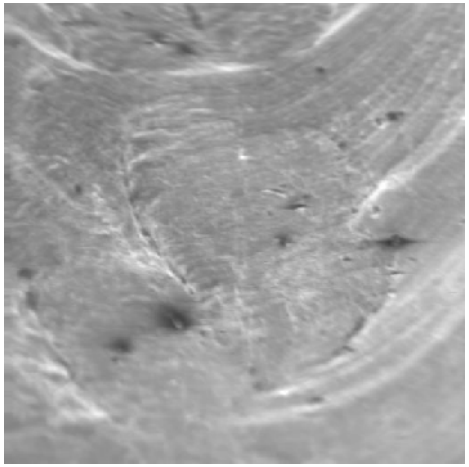
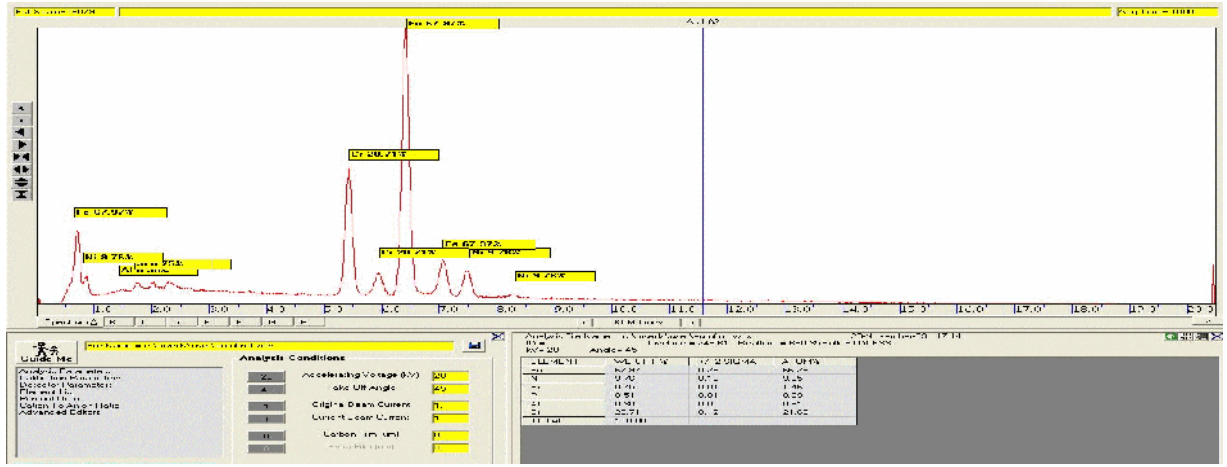
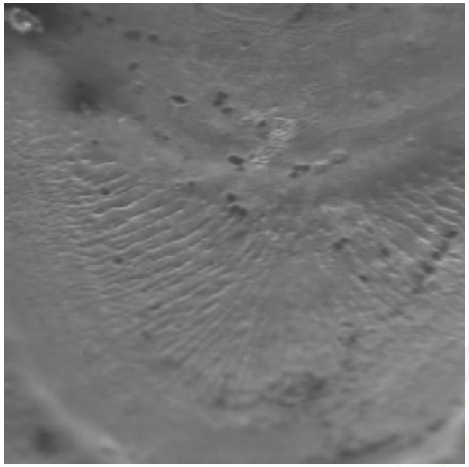
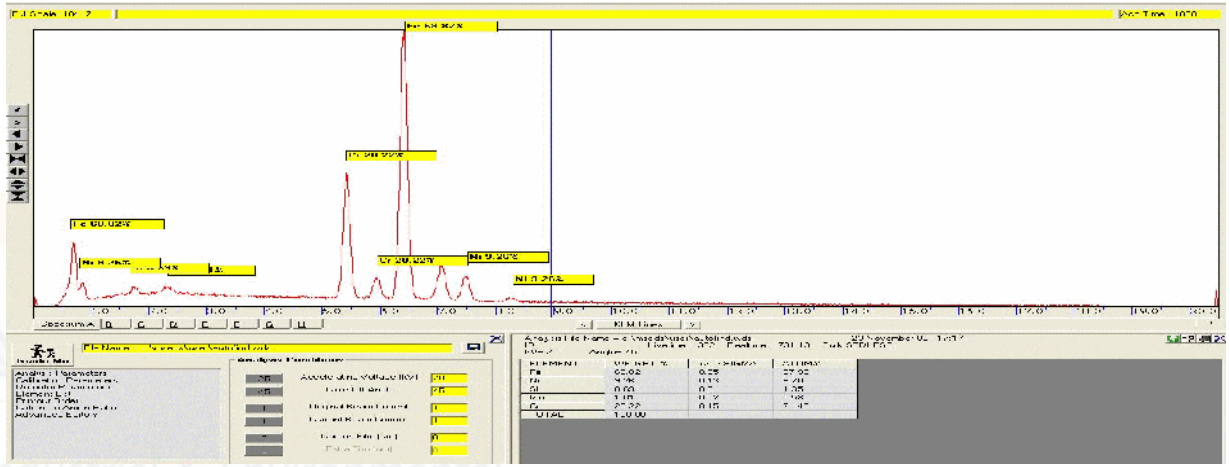
Sample E





Sample F





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