

Transition elements and transmutation.

There are a number of properties shared by the transition elements that are not found in other elements, which results from the partially filled d shell. These include

- the formation of compounds whose colour is due to $d - d$ electronic transitions
 - the formation of compounds in many oxidation states, due to the relatively low reactivity of unpaired d electrons.[12]
 - the formation of many **paramagnetic** compounds due to the presence of unpaired d electrons. A few compounds of main group elements are also paramagnetic (e.g. **nitric oxide**, **oxygen**)
- Colour in transition-series metal compounds is generally due to electronic transitions of two principal types.

•**charge transfer** transitions. An electron may jump from a predominantly **ligand orbital** to a predominantly metal orbital, giving rise to a ligand-to-metal charge-transfer (LMCT) transition. These can most easily occur when the metal is in a high oxidation state. For example, the colour of **chromate**, **dichromate** and **permanganate** ions is due to LMCT transitions. Another example is that **mercuric iodide**, HgI_2 , is red because of a LMCT transition.

A metal-to ligand charge transfer (MLCT) transition will be most likely when the metal is in a low oxidation state and the ligand is easily reduced.

• $d-d$ transitions. An electron jumps from one **d-orbital** to another. In complexes of the transition metals the d orbitals do not all have the same energy. The pattern of splitting of the d orbitals can be calculated using **crystal field** theory. The extent of the splitting depends on the particular metal, its oxidation state and the nature of the ligands.

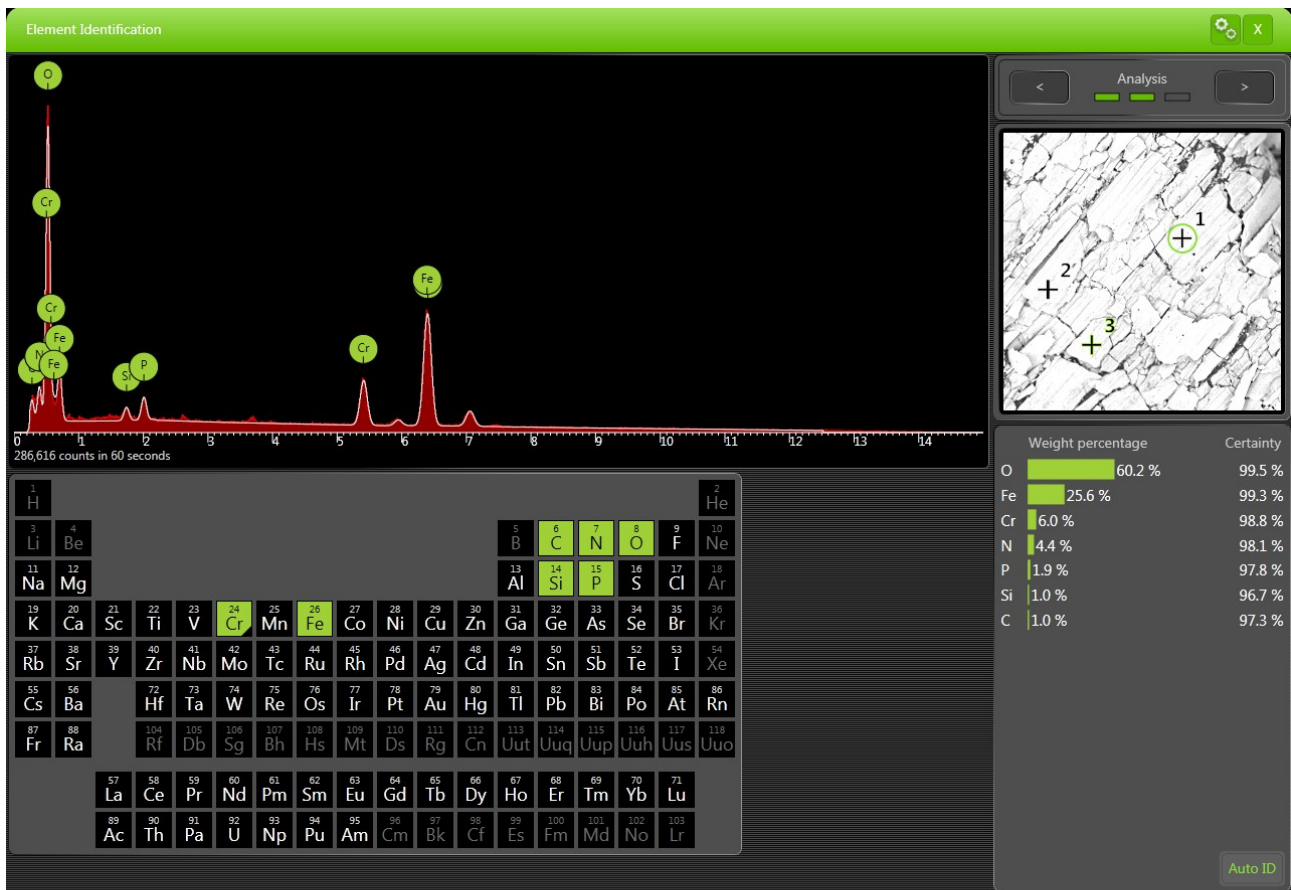
The following are actual SEM X-ray analysis of an SMD experiment. The first is a sample of the deposit taken from the electrode. The high lighted elements in green are the elements found, and the lit up elements are the ones switched on for detection. Notice that B “Boron” is not on and I will come to that later. The second is of the electrolyte which was dried to leave the residue, both are from the same experiment. The electrolyte was sodium acetate and the electrode 304 stainless steel of which is known the alloy make up by % weight of each element to start with.

The first thing to note is that there is no Na on the electrode deposit, but the electrolyte showed a high %. Now it would be expected to show a high % in the electrolyte, but why “zero %” on the electrode which was in that electrolyte!

Now fusions of two elements are for example, two oxygen's with the atomic number of 8 will give $8+8=16$ sulphur, which includes the energy in those numbers to fuse them together. This can also be a three way chain as has been seen in the following SEM's, a complex of reaction. No notice should be taken of the gold Au as this was added due to the high voltage in the SEM melting the deposit, so the 11.1% should be divided by 5 and added to each element.

We started with:-

Now 304L stainless steel has Cr 18-20%, Ni 8-12%, C 0.03%, Mn 2%, Si 0.75%, P 0.04%, S 0.03%, N 0.1% to start with, and the electrolyte (aqu:) is CH_3COONa . The balance is Fe 68%. in the SS.



SAE designation	UNS designation	% Cr	% Ni	% C	% Mn	% Si	% P	% S	% N	Other
Austenitic										
201	S20100	16–18	3.5–5.5	0.15	5.5–7.5	0.75	0.06	0.03	0.25	-
202	S20200	17–19	4–6	0.15	7.5–10.0	0.75	0.06	0.03	0.25	-
205	S20500	16.5–18	1–1.75	0.12–0.25	14–15.5	0.75	0.06	0.03	0.32–0.40	-
254 [9]	S31254	20	18	0.02 max	-	-	-	-	0.20	6 Mo; 0.75 Cu; "Super austenitic"; All values nominal
301	S30100	16–18	6–8	0.15	2	0.75	0.04 5	0.03	-	-
302	S30200	17–19	8–10	0.15	2	0.75	0.04 5	0.03	0.1	-
302B	S30215	17–19	8–10	0.15	2	2.0–3.0	0.04 5	0.03	-	-
303	S30300	17–19	8–10	0.15	2	1	0.2	0.15 min	-	Mo 0.60 (optional)
303Se	S30323	17–19	8–10	0.15	2	1	0.2	0.06	-	0.15 Se min
304	S30400	18–20	8–10.50	0.08	2	0.75	0.04 5	0.03	0.1	-
304L	S30403	18–20	8–12	0.03	2	0.75	0.04 5	0.03	0.1	-
304Cu	S30430	17–19	8–10	0.08	2	0.75	0.04 5	0.03	-	3–4 Cu
304N	S30451	18–20	8–10.50	0.08	2	0.75	0.04 5	0.03	0.10–0.16	-
305	S30500	17–19	10.50–13	0.12	2	0.75	0.04 5	0.03	-	-
308	S30800	19–21	10–12	0.08	2	1	0.04 5	0.03	-	-
309	S30900	22–24	12–15	0.2	2	1	0.04 5	0.03	-	-
309S	S30908	22–24	12–15	0.08	2	1	0.04 5	0.03	-	-
310	S31000	24–26	19–22	0.25	2	1.5	0.04 5	0.03	-	-
310S	S31008	24–26	19–22	0.08	2	1.5	0.04	0.03	-	-

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314	S31400	23–26	19–22	0.25	2	1.5–3.0	0.04 5	0.03	-	-
316	S31600	16–18	10–14	0.08	2	0.75	0.04 5	0.03	0.10	2.0–3.0 Mo
316L	S31603	16–18	10–14	0.03	2	0.75	0.04 5	0.03	0.10	2.0–3.0 Mo
316F	S31620	16–18	10–14	0.08	2	1	0.2	0.10 min	-	1.75–2.50 Mo
316N	S31651	16–18	10–14	0.08	2	0.75	0.04 5	0.03	0.10–0.16	2.0–3.0 Mo

Now lets put this into some sort of order, the hydrogen was switched off so is not in the table to start with, the oxygen which was forming oxides has to be removed and the %'s adjusted to give a real definition of what we have as far as elements are concerned.

	304L	Electrode solid	Electrolyte dried
Fe	68	35.6	----
Cr	19	16	----
Ni	10	----	----
Mn	2	----	----
Si	0.75	11	----
N	0.1	14.4	10.78
P	0.04	11.9	----
C	0.03	11	10.48
Na	----	----	61.08
Al	----	----	9.58

In both electrode solid and electrolyte the nitrogen (N) is very high and would seem to be a transition reaction of $H+C=N$

In the electrolyte the appearance of aluminium (Al) can only be explained by a transition reaction of $C+N=Al$

The high level of silicon (Si) could be due to a stepping stone transition reaction of $(C+N)+H=Si$. Also phosphorus (P) could be an $N+O$ transition reaction.

The anomalies are plain to see.

