Spectroscopy Application Note

Quantitative Depth Profile (QDP) Analysis of Aluminum Clad

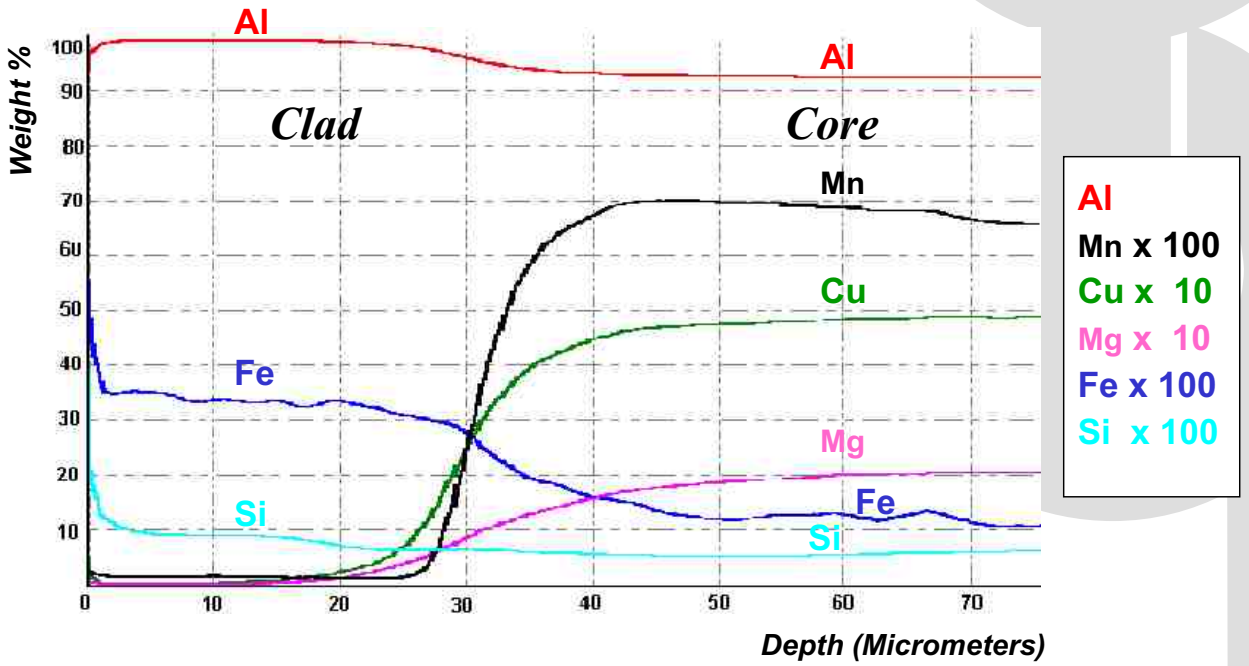
- **Chemical Composition for the Clad and Core**
- **Migration at Interface; Problem of Corrosion**
- **Contamination at the Surface**

GDS-400A

Aluminum clad is a product made of two aluminum sheets bonded together by pressure and heat. Commonly, the substrate (core) is made of alloyed aluminum, more or less alloyed depending on applications. The aluminum "surface" sheet (clad), bonded by pressure and heat, is usually pure or low alloyed aluminum. The clad is used to protect the core from the corrosion.
Aluminum clad is used in the automotive industry for air conditioners, radiators and associated products, as well as in the aeronautic field for the "skin" of planes. The thickness of the clad may vary from several tens of micrometers to more than 100 micrometers.
Aluminum companies have manufactured this type of product for many years. The technology is well proven, and glow discharge-optical emission spectroscopy (GD-OES) techniques can verify quality and solve some problems occurring during the process.

GD-OES Applications for Control of Aluminum Clad Materials

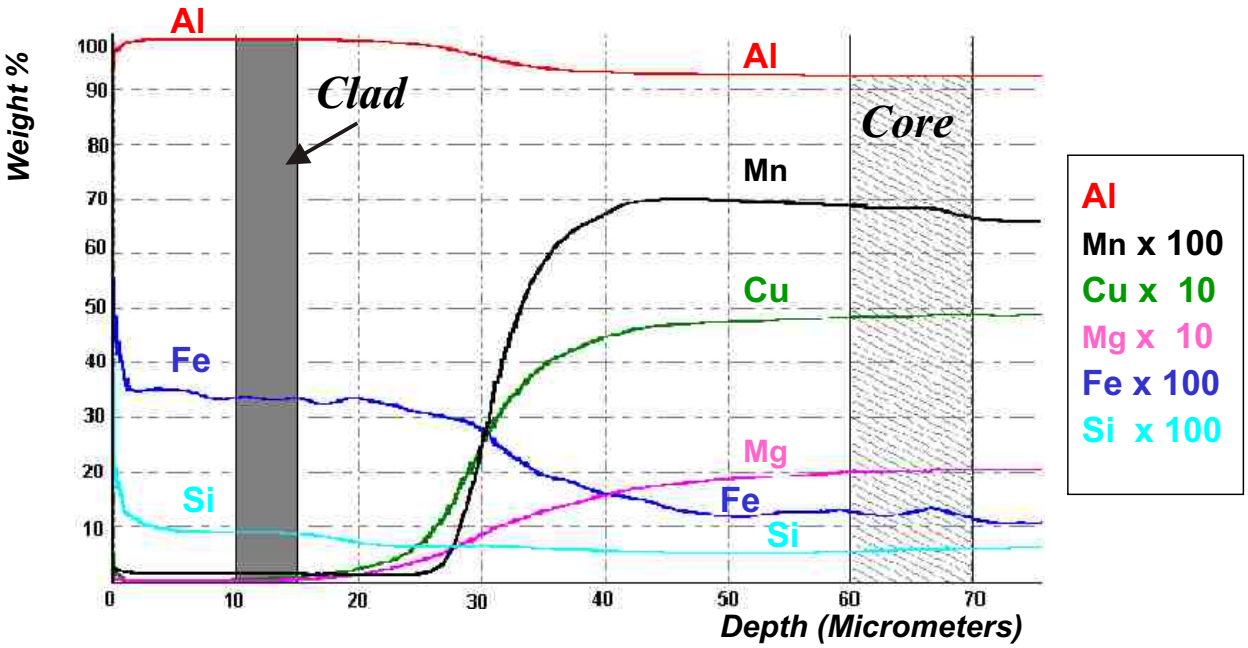
Chemical Composition for Clad and Core: Depth Profile Analysis will provide the continuous chemical composition of materials from the surface, through the clad, and into the core. A diagram (below) representing the concentration on the Y-axis versus the depth on the X-axis is available after the calibration step.



An example of 30 microns clad is shown above. The complete profile from the surface to the core, (approximately 80 microns), was obtained in less than 30 minutes.

GDS-Series

By defining an integration area in the clad and in the core, the software calculates the average chemical composition of both the clad and the core. An example is provided below.



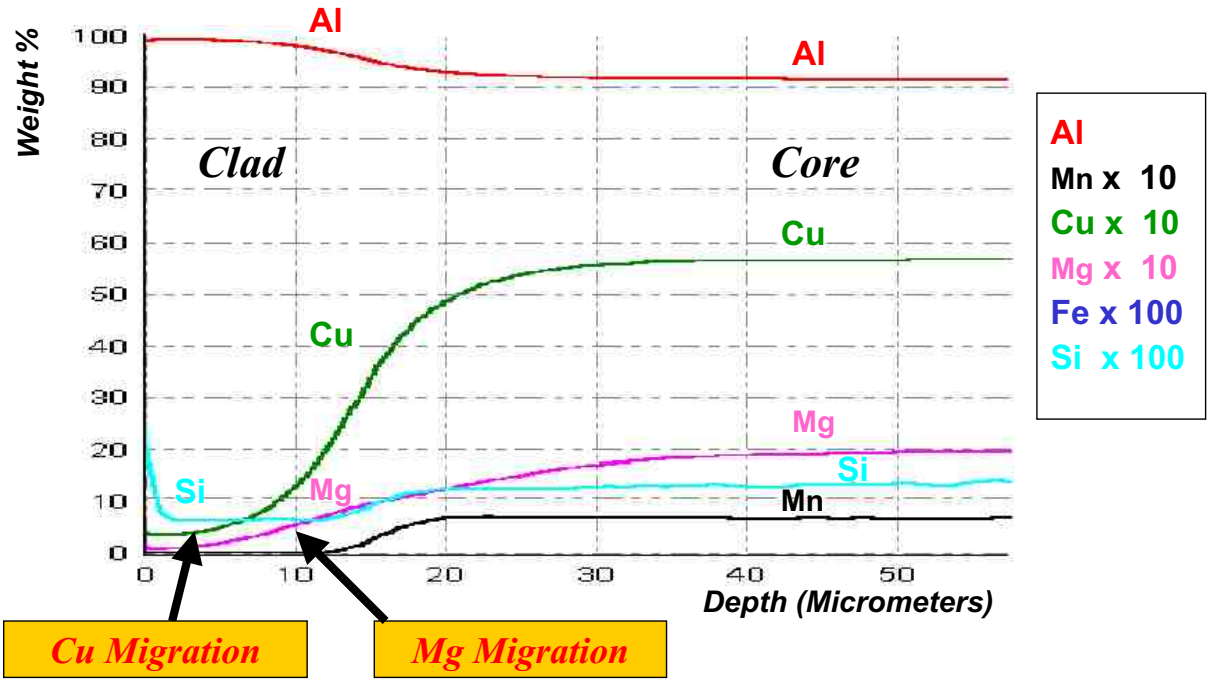
Al %(clad)	Cu %(clad)	Fe %(clad)	Mg %(clad)	Mn %(clad)	Si %(clad)	Zn %(clad)
99.00	0.056	0.33	0.033	0.013	0.088	0.144

Al %(core)	Cu %(core)	Fe %(core)	Mg %(core)	Mn %(core)	Si %(core)
92.28	4.84	0.124	1.99	0.874	0.056

The chemical composition is calculated instantaneously after acquiring the profiles.

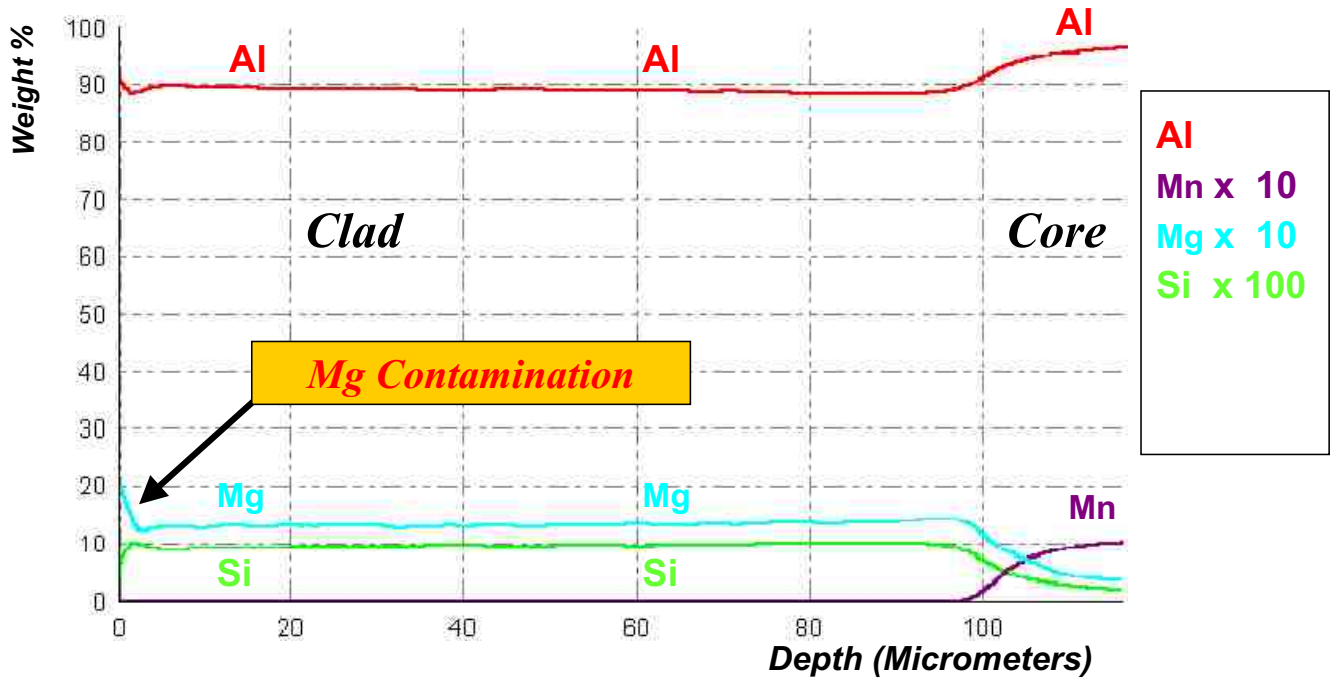
Migration at Interface; Problem of Corrosion: The purpose of the clad (pure aluminum) is to protect the core against corrosion. Sometimes during the process, elements like Cu and Mg migrate from the core to the surface through the clad. If the composition of the clad is modified in this manner, the clad loses its role of anticorrosion.

The following example, showing a 15 micron aluminum clad (different from the previous one), illustrates the migration of Cu and Mg to the surface. High Cu at the surface may lead to corrosion.

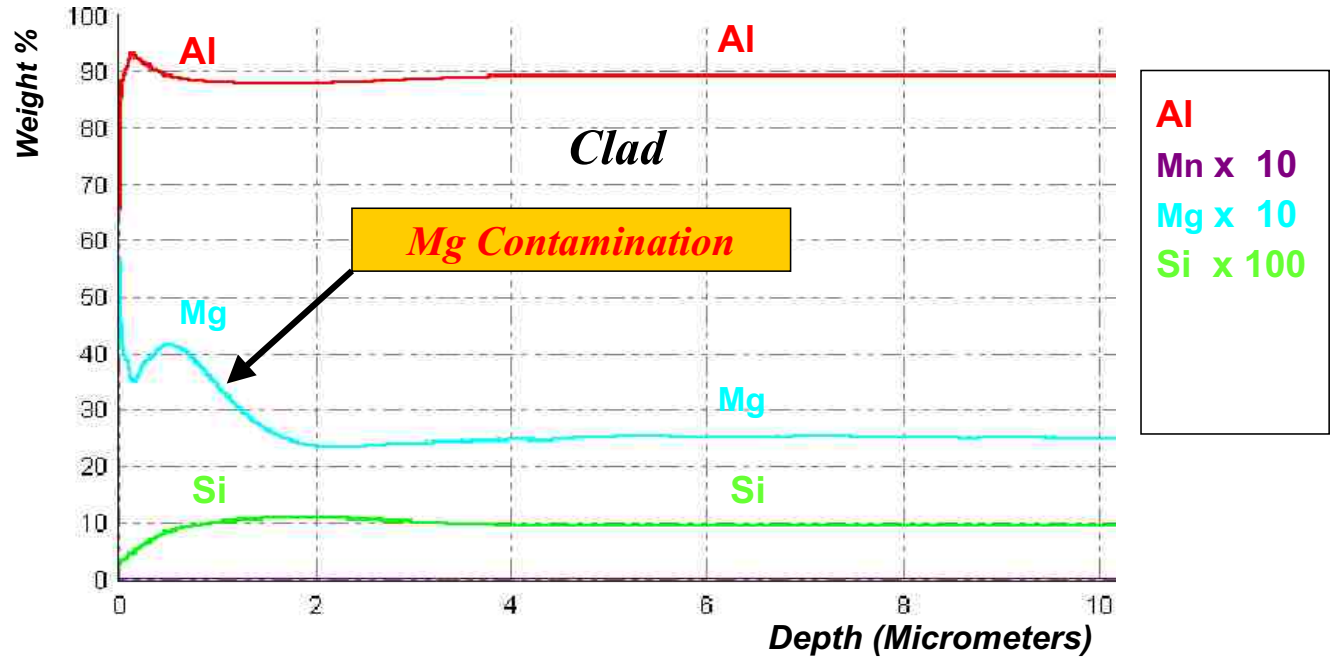


In less than 15 minutes, the operator can check if the process is correct and can alert production for any deviation in the product quality. If some migration occurred, the GD-OES technique can help to predict a poor resistance to corrosion for this product. For a sample already corroded, depth profile analysis identifies the elements in the clad contributing to the corrosion and explains the origin of the corrosion.

Contamination at the Surface: During the rolling process, the surface of the clad can be contaminated with Mg coming from the rolls. The following example illustrates this contamination.



Complete depth profile of 100 microns clad



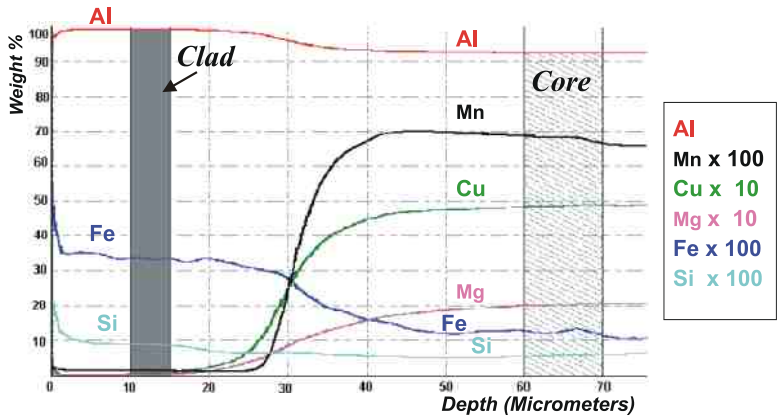
Expansion from 0 to 10 microns, showing an increase in Mg at the surface

Report Generator

The report generator, part of the QDP software, helps the operator to easily produce a polished report. Documents like the one below can be obtained automatically.

REPORT GENERATOR

Application: Aluminum Clad



Coating Composition (%)

Depth (µm)	Al (%)	Cu2 (%)
0.0	79.0	1.95
5.0	98.8	0.0150
10.0	99.2	0.0200
15.0	99.0	0.0369
20.0	98.7	0.0894
25.0	98.5	0.293
30.0	97.2	1.27
35.0	94.8	3.25
40.0	93.4	4.15
45.0	92.9	4.55
50.0	92.6	4.71
55.0	92.5	4.72
60.0	92.5	4.79
65.0	92.4	4.82
70.0	92.3	4.84
75.0	92.3	4.87
80.0	92.1	4.93
85.0	92.2	4.92
90.0	92.2	4.95

Al % (clad)	Cu % (clad)	Fe % (clad)	Mg % (clad)	Mn % (clad)
99.00	0.056	0.33	0.033	0.013

Si % (clad)	Zn % (clad)
0.088	0.144

Al % (core)	Cu % (core)	Fe % (core)	Mg % core)
92.28	4.84	0.124	1.99

Mn % (core)	Si % (core)
0.674	0.056

Summary

After less than 30 minutes of acquisition, the operator obtains:

- continuous chemical composition from the surface to the core
- average chemical composition for the clad and core
- information concerning homogeneity
- information on the contamination at the surface and on the migration occurring at the interface

The GD-OES technique provides valuable information for:

- control of the process and display of deviation (migration of elements)
- quality control of the finished product and anticipation of problems (i.e. corrosion)
- investigation in R&D to explain the origin of unexpected phenomena (i.e. corrosion)

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