



27.11.1997

Università degli Studi di Napoli 'Federico II'  
Department of Materials and Production Engineering  
Degree Thesis in Materials Engineering  
**'Corrosion and Protection of Aluminum Alloys'**  
Giovanni Lapelazzuli  
(Supervisor: Prof. F. Bellucci)

### **Guidelines and Main Goals Achieved**

The research, carried out during 1997, can be described as a study of the corrosion behaviour of Aluminium Alloys and of the reliability of the Electrochemical Impedance Spectroscopy (EIS) as an investigation tool.

All the research activities were developed thanks to the collaboration between the Department of Materials and Production Engineering (DIMP) of the University of Naples 'Federico II' and the Laminazione Sottile Group, a company leader in the production of aluminium alloys' sheets.

### **Background**

Chromate conversion coatings such as the currently specified Alodine treatment have been identified as a large unacceptable source of hazardous waste generation and danger to worker health and safety. Chromate conversion coatings have been utilised to promote adhesion and corrosion resistance of organic coating systems (primer-topcoat), but efforts to develop finishing systems that do not incorporate a pre-treatment have not demonstrated comparable performance.

Another source of unacceptable hexavalent chromium is the sodium dichromate seal used in the aluminium anodising process. Removal and disposal of the additional hexavalent chrome from the process waste water exacerbates the cost and the potential health safety problem. The use of non-chromate sealing system will permit an anodizer to eliminate one hazardous constituent. This effort has not been funded previously.

### **Goals**

The fundamental goal of the study has been the evaluation of the protecting performances of alternative conversion treatments and the analysis of all the aluminium alloys' sheets production's process, from the fusion-casting step to the polymer's coating one. The investigating technique used has been the Electrochemical Impedance Spectroscopy (EIS).

### **Thesis Structure**

The Thesis has been structured in 5 chapters:

In Chapter I the entire production process is described (fusion, casting, lamination, thermal treatment, conversion treatment, polymer's coating);

In Chapter II is explained the theory upon which the EIS is based, its application to the Corrosion Science, and the equivalent circuits' theory which is essential for a correct interpretation of the experimental data;

In Chapter III are described the Materials and the Methods;

In Chapter IV are shown the results and the conclusions regarding the corrosion behaviour of the alternative conversion treatments studied;

In Chapter V are shown the protective properties of all the polymer coatings analysed.

### **Results and Conclusions**

1. The chemical composition of the alloys drastically influences their corrosion performances. The alloys with an higher iron and copper content present a lower degradation resistance, due to the galvanic micro coupling phenomena between this components and the aluminium;

2. The chromate conversion treatment improves the corrosion resistance of the goods;

3. The lamination step causes discontinuities and holes in the conversion layer, which act as preferential corrosion sites, lowering the overall resistance of the sheets;

4. The alternative conversion treatments have shown good protecting and adhesive performances. This treatments, even if not yet comparable to the traditional ones, are greatly promising and could bring in the future, with a more precise and careful control of all the technological variables involved in the process, to a definite substitution of the chromate based ones ;

5. The electrochemical tests have shown how a multi layer organic coating could offer, with the same thickness, a protecting action much more performing then the single layer ones.

The EIS has confirmed the great potentialities as investigating technique for the analysis of the corrosive behaviour of metals and of the protective properties of the organic coatings.