

## DEFFECTS IN THE AA8006 ALUMINUM ALLOY SHEETS

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*Aliajele de aluminiu AA8006 sunt din ce în ce mai mult utilizate pentru fabricarea tablelor și a foliilor.*

*Pentru a pune în evidență rolul Fe, Mn și Si în procesele de solidificare și laminare s-a studiat microstructura și defectele de suprafață ale unor table produse din aliajul AA8006. Studiul s-a efectuat prin microscopie optică, microscopie electronică (SEM) și EDS.*

*The AA8006 aluminum alloys are more and more used for manufacturing sheets and foils.*

*In order to put in evidence the role of iron, manganese and silicon in the solidification and rolling processes, the microstructure and surface defects of some AA8006 sheets was studied. The investigation was carried out by optical, scanning electron microscopy and energy dispersive X-ray spectroscopy.*

**Keywords:** microstructure, sheet, defects, Al alloys

### 1. Introduction

The AA8000 (8001-8030) aluminum alloys are recently developed materials. In this serie of alloys the alloying elements are: Fe, Sn, Ce, Li, Cu, Si, Zn, Mg, Ni and Mn.

The AA8006 alloy is more and more used for manufacturing sheets and foils. The chemical composition of this alloy is given in Table 1.

Table 1

Chemical composition of AA8006 alloy

Element	wt. %	Element	wt. %
Al	95.9 – 98.5	Mg	0.1 max.
Mn	0.3 – 1.0	Cu	0.3 max.
Fe	1.2 – 2.0	Zn	0.1 max.
Si	0.4 max.	Other	0.05

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The phase composition of the 8006 alloy at a low content of Si impurity can be considered by using the Al-Fe-Mn diagram.

From the ternary Al-Fe-Mn phase diagram we can remark that in the aluminum corner of the Al-Fe-Mn ternary system only two phases  $\text{FeAl}_3$  and  $\text{Al}_6(\text{FeMn})$  can be in equilibrium with Al [1].

The combined effect of Mn, Fe and Si on the phase composition of 8006 alloy can be analyzed only by a quaternary phase diagram. The isothermal and polythermal sections of the Al-Fe-Mn-Si phase diagram show that the presence of Fe and Si leads generally to the formation of the  $\text{Al}_{15}(\text{FeMn})_3\text{Si}_2$  phase.

In order to put in evidence the role of iron, manganese and silicon in the solidification and rolling processes the authors have studied the microstructure of the AA8006 sheets.

## 2. Results and Discussion

The nominal composition of the 8006 alloys in wt.% was: 1.55 Fe, 0.44 Mn, 0.12 Si, and balance Al. Examination of sheets microstructure proved that it could have different intermetallic phases ( $\text{AlFe}$ ,  $\text{AlMn}$ ,  $\text{AlFeMnSi}$ ). The type of these intermetallic phases will affect the properties of sheets [2,3].

Studies were conducted on the samples taken from industrial scale production. The samples from rolled sheets with 0.13 mm, 0.23 mm and 0.4 mm thickness have been investigated through quantitative metallographic analysis and Scanning Electron Microscopy on the XL 30 ESEM equipped with EDS and on JEOL JXA 50A Electron Probe Micro-analyser.

Samples were prepared by cutting, mounting and grinding. The etching was made with a 0.5% HF solution.

The intermetallic particles have an alignment tendency after the rolling direction. The particles are large enough having between 15  $\mu\text{m}$  and 35  $\mu\text{m}$  (Fig.1 and Fig.2).

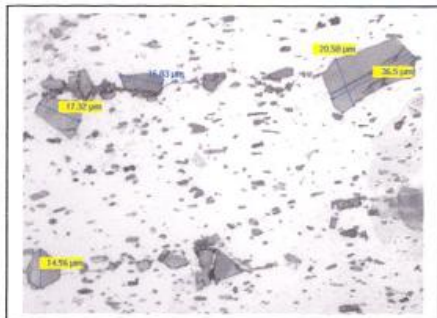


Fig.1. Microstructure of the AA8006 rolled sheet with 0.13 mm thickness, x1000.

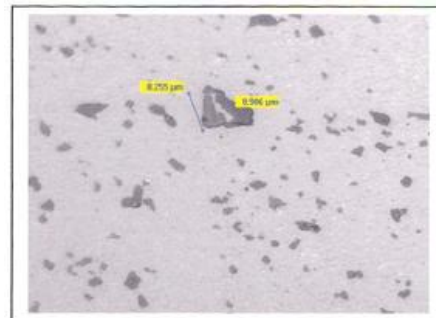


Fig.2. Microstructure of the AA8006 rolled sheet with 0.23 mm thickness, x1000.

The light grey secondary particles of  $\alpha$ -AlMnFeSi in the middle of the AlFeMn dark grey intermetallic phase is observed [4].

The presence of AlFeMn cracked particles on the surface of sheets were observed, and composition was done by EDS microanalysis (Fig.3).

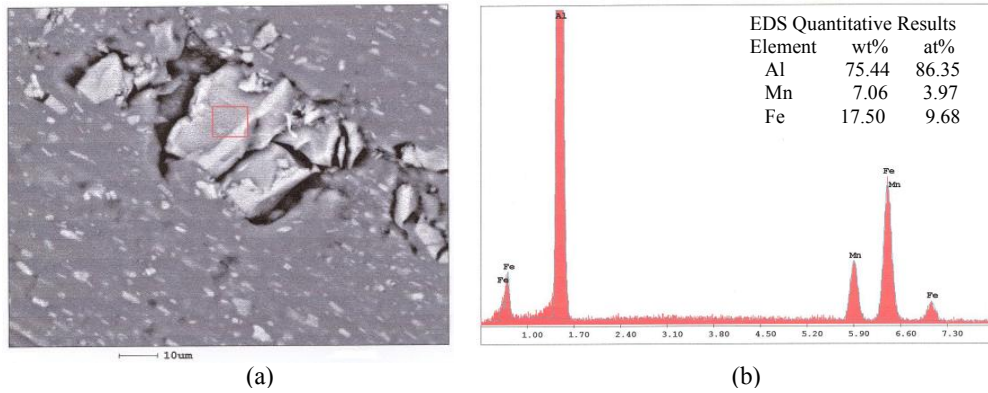


Fig.3. SEM microscopy of the AA8006 sheet, with 0.13 mm thickness (a) and EDS analysis (b).

At the surface of AlFeMn particles we can see aluminum oxide particles (Fig.4).

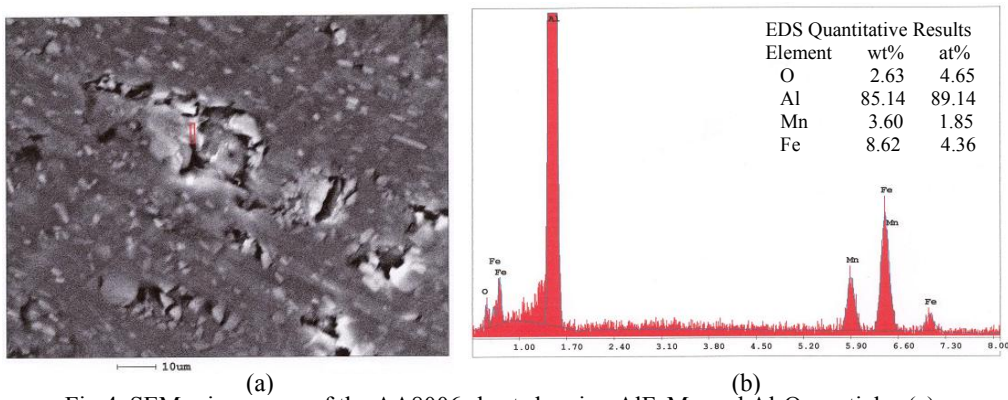


Fig.4. SEM microscopy of the AA8006 sheet showing AlFeMn and  $\text{Al}_2\text{O}_3$  particles (a) and EDS analysis (b).

The presence of polyhedral AlFeMn and spherical AlFeMnSi compounds were put in evidence by X-ray images of Fe, Mn, Si and Al (Fig.5 and Fig.6).

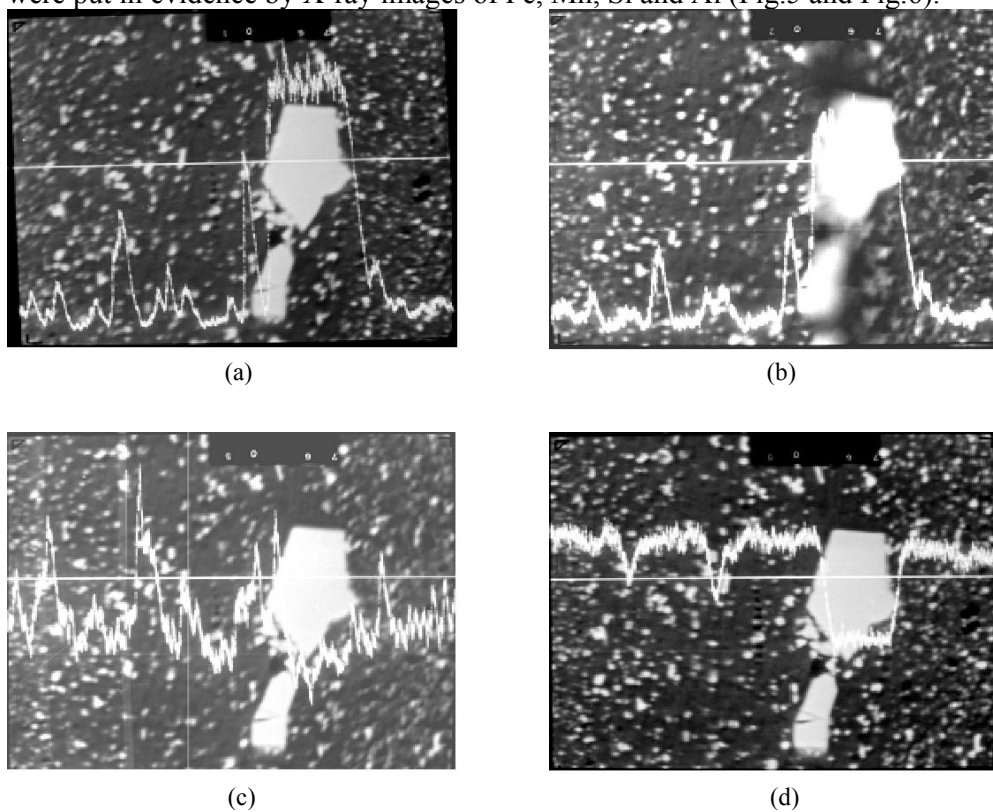


Fig.5. Variation profile of Fe (a), Mn (b), Si (c) and Al (d) for polyhedral AlFeMn compound.

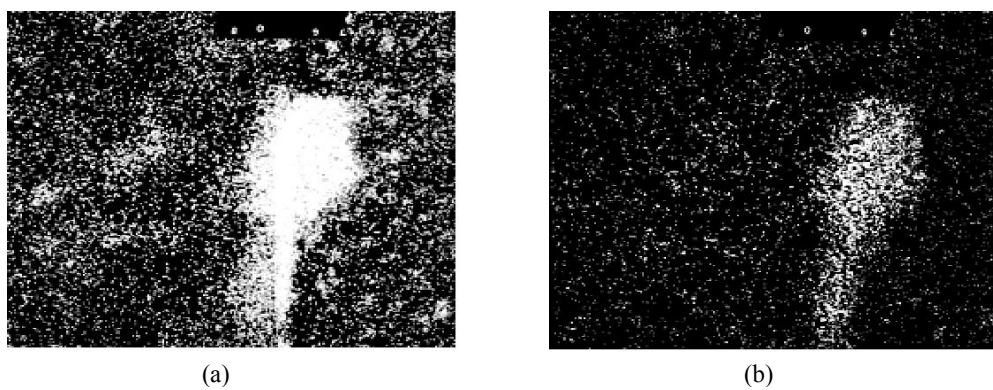


Fig.6. X-ray images for Fe (a) and Mn (b) for a spherical compound.

Aluminum oxide and/or spinel ( $\text{MgO} \cdot \text{Al}_2\text{O}_3$ ) on the surface of sheets are observed in Fig.7. It is more likely for these inclusions to become sources of pinhole in the sheets.

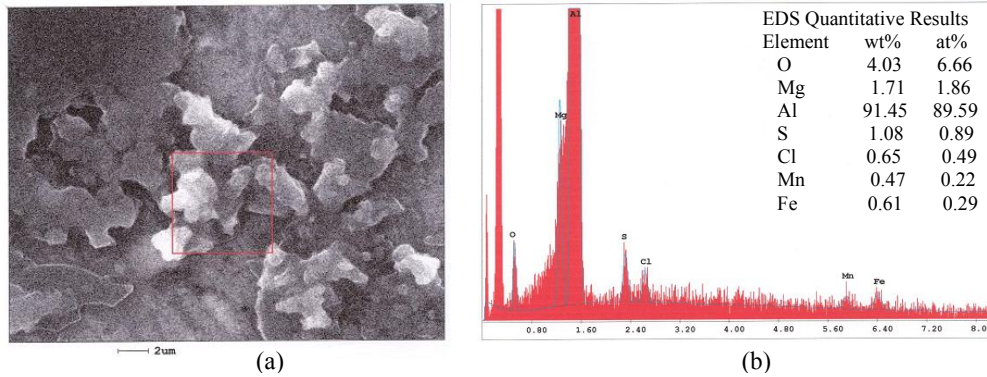


Fig.7. SEM (a) and EDS analysis (b) of AA8006 sheet with 0.13 mm thickness.

Also, on the surface of the sheets we can see spherical particles of aluminum boride (Fig.8). They are small in size and non-deformable particles compared to the ductile aluminum matrix, but they can affect the performance of the sheet rolling.

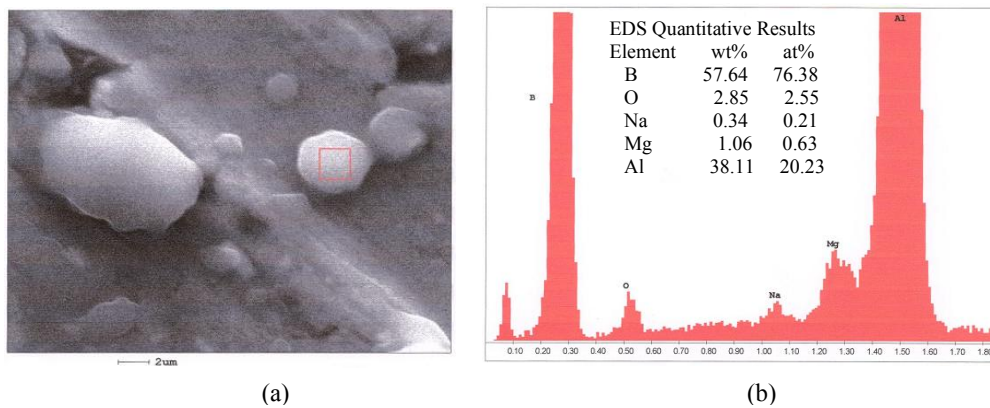


Fig.8. SEM (a) and EDS analysis (b) of aluminum boride.

### 3. Conclusions

- The presence of AlFeMn cracked particles on the surface of sheets was observed.
- The intermetallic particles ( $15\mu\text{m}$  -  $35\mu\text{m}$ ) have an alignment tendency after the rolling direction.
- Polyhedral AlFeMn and spherical AlFeMnSi particles were put in evidence by X-ray images of elements.
- Aluminum oxide,  $\text{MgO} \cdot \text{Al}_2\text{O}_3$  spinel and aluminum boride were observed on the surface of the sheets.

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