

# The influence of the deformation processes on the microstructure of the annealed 6063 aluminium alloy

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Several studies have shown that for many structural aluminium alloys, the combination of strength and toughness is intimately related to the work hardening. The analysis and control of work hardening has proven to be one of the problems of materials science, both because of the complexity of the dislocation processes involved and the non homogeneity of their operation within the deforming microstructure [1]. The commercial aluminium alloys are characterized invariably by having multiphase microstructure and that is the case of the 6063 Al alloy (Al-Mg-Si-Fe). A better way to understand the influence of the deformation processes on the microstructure in an annealed 6063 Al alloy is by TEM observation where there are higher magnification. In this work is shown briefly the influence of some deformation processes on the final microstructure of an initially annealed 6063 Al alloy, specifically cold torsion, cold extrusion and tensile deformation, individually or a combination of both of them. The principal aim is to observe the similarities and the differences in each process or in a combination of them. There are few information about it in the literature. All the TEM (employed accelerated voltage = 200kV) observations was made in samples obtained from the cross section of the cylindrical pieces of the wrought alloy.

The figure 1 shows an intense and regular cell structure in the three observed grains in the annealed 6063 Al alloy who was cold deformed in torsion for 20 cycles (2.8% of reduction on thickness). There are also some presence of  $FeAl_3$ ,  $Fe_3SiAl_{12}$  and  $Mg_2Si$  identified precipitates who was random distributed. The figure 2 shows a more fine and regular cell structure and presence of same identified precipitates in the annealed 6063 Al alloy who was cold deformed in torsion (2.8%) and finally cold deformed on tensile test (2.8%). The figure 3 shows a random subgrains structure and a dislocation network inside the grains in the annealed 6063 Al alloy who was cold extruded (2 steps, 2.8% each one). The figure 4 shows several grains containing a random subgrain structure with some cellular structure inside them together some identified precipitates in the annealed 6063 Al alloy who was cold extruded (1 step, 2.8%) and cold deformed on torsion (20 cycles, 2.8%). The figure 5 shows fine subgrains, dislocation tangles near each sub-boundary,  $Fe_3SiAl_{12}$  and  $Mg_2Si$  precipitates in the annealed 6063 Al alloy who was cold extruded (2.8%) and cold deformed on tensile test (2.8%).

The sequence of TEM micrographs, the cell structure or subgrain formation/morphology, the dislocation network interaction with precipitates or grains / sub-grains, can elucidate some theoretical aspects about the possible involved hardening mechanism and consequently could enhanced the final structural properties of the wrought 6063 aluminium alloy for industrial purposes as an example.

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## References

1. Chu, D. and Morris Jr, J. W., Acta mater., 44 (1996) 2599.

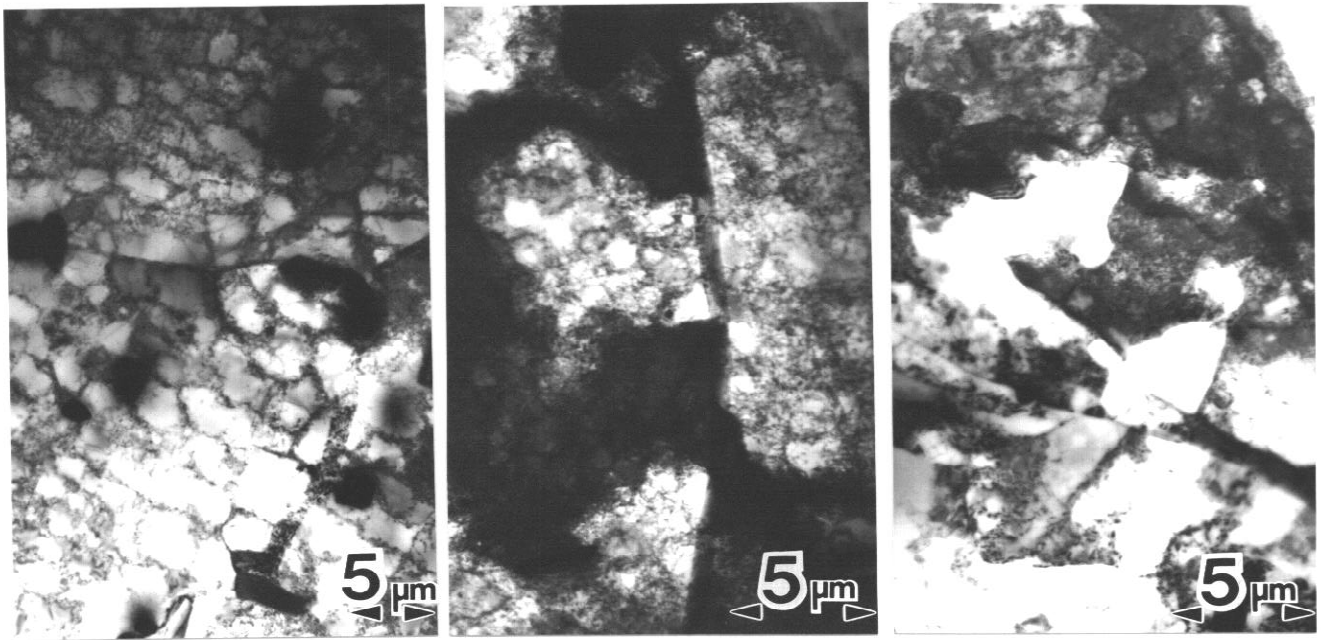


FIG.1- A regular cell structure and  $\text{FeAl}_3$ ,  $\text{Fe}_3\text{SiAl}_{12}$  and  $\text{Mg}_2\text{Si}$  precipitates in a 6063 Al alloy cold deformed on torsion (2.8%), TEM observation ( 200kV ), Zone Axis  $\approx (011)$ .

FIG.2- Fine and regular cell structure and precipitates in a 6063 Al alloy cold deformed on torsion (2.8%) and deformed on tensile test (2.8%), TEM observation ( 200 kV ), Zone Axis  $\approx (013)$ .

FIG.3- Subgrain structure and a dislocation network inside the observed grains in a 6063 Al alloy cold extruded in two steps (2.8% each one), TEM observation ( 200 kV ), Zone Axis  $\approx (011)$ .

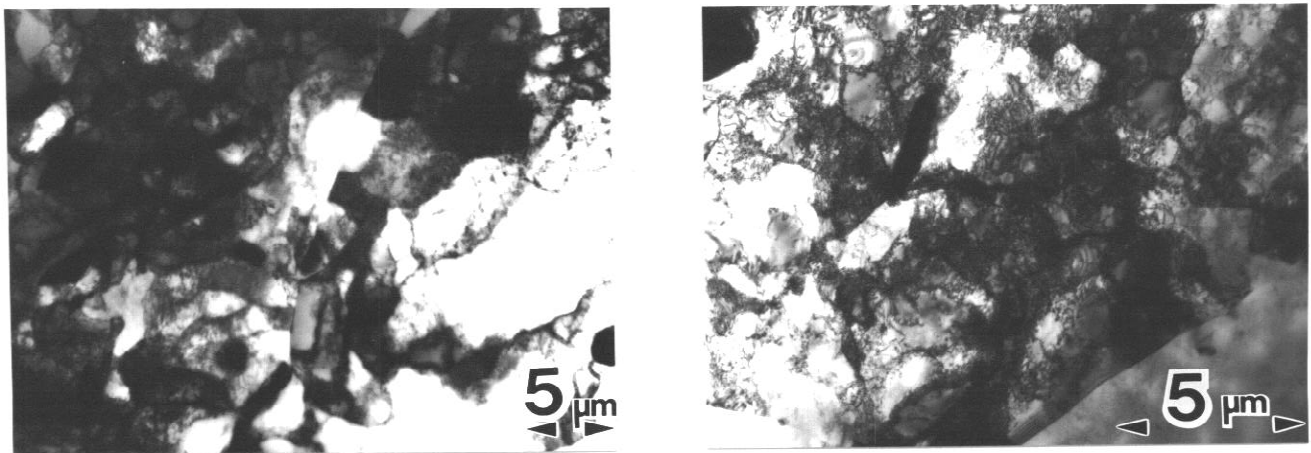


FIG.4- Grains containing a random subgrains structure with precipitates and some cell structure inside them in the 6063 Al alloy cold extruded (2.8%) and finally cold deformed on torsion (2.8%), TEM observation ( 200 kV ), Zone Axis  $\approx (011)$ .

FIG.5- Fine subgrains and dislocation tangles near each sub-boundary in the 6063 Al alloy cold extruded (2.8%) and finally cold deformed on tensile test (2.8%).  $\text{Fe}_3\text{SiAl}_{12}$  and  $\text{Mg}_2\text{Si}$  precipitates,