



Development of high- performance Nano-alu material

Development of high performance light weight structural
materials by synthesizing ceramic nano-particles with
Aluminum alloys matrices

Examination of specimens that were produced by ECENARRO and by
EDERTEK

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Specimens that were produced by ECENARRO (27.03.2010)

Aluminum Alloy 6063

A picture of a typical specimen that was tested:



1. Compression Test

Comparative compression tests were carried out for comparison between two groups of specimens: 1. 6063 alloy and 2. 6063 alloy reinforced with 1%SiC nano-particles. 4 types of specimens from each group were tested: F (as fabricated), T4, T5 and T6 heat treated.

6 specimens of each group were tested. The specimens were tested on "INSTRON 3369" mechanical testing machine.

Test results are shown in table 1.

Table 1- compression tests results

Alloy	Heat treatment	Max.Load , kN average	Max.Displacement average, mm
6063	F	40.31	7.544
6063-1%SiC.	F	40.39	7.797
6063	T4	40.40	8.484
6063-1%SiC.	T4	40.59	8.698
6063	T5	40.20	7.956
6063-1%SiC.	T5	40.31	8.541
6063	T6	40.34	5.785
6063-1%SiC.	T6	40.23	6.330

Specimens before and after compression tests are shown in Fig.1



Fig.1- Specimens before and after compression tests.

2. Microhardness Test

Vickers microhardness (HV) was measured on the longitudinal axis by applying a load of 100g for 15sec (see Fig.2).

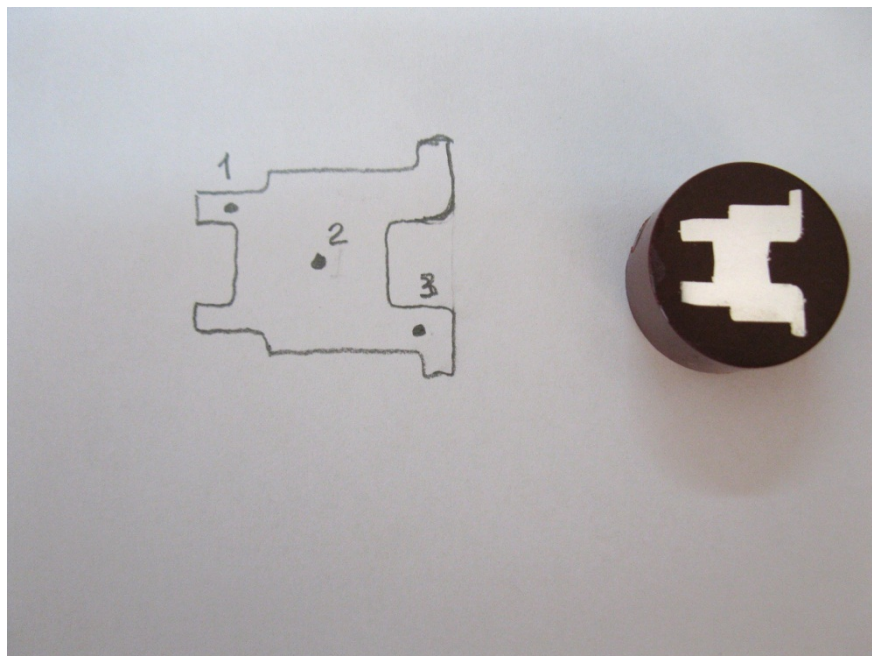


Fig . 2 Microhardness test points.

The microhardness test results are shown in table 2.

Table 2- Microhardness tests results

Alloy	Heat treatment	HV test results			HV average
		1	2	3	
6063	F	84.8	78.2	75.8	81.6
6063	F	84.8	86.9	79.0	
6063-1%SiC.	F	87.9	78.5	81.0	81.9
6063-1%SiC.	F	85.2	74.3	84.2	
6063	T4	61.4	53.5	61.7	58.7
6063	T4	61.4	57.8	56.1	
6063-1%SiC.	T4	67.2	57.2	60.5	60.2
6063-1%SiC.	T4	61.2	51.0	64.2	
6063	T5	72.9	70.0	76.8	73.8
6063	T5	74.0	73.1	76.1	
6063-1%SiC.	T5	74.9	73.4	73.4	75.3
6063-1%SiC.	T5	76.4	73.6	80.0	
6063	T6	87.4	85.2	87.6	85.3
6063	T6	79.6	85.8	85.9	
6063-1%SiC.	T6	85.6	89.0	85.4	86.9
6063-1%SiC.	T6	84.7	91.6	85.0	

3. Microstructure test

The microstructure of the specimens was observed using optical microscope - Nikon 30 and scanning electron microscopy (SEM) on polished sections etched in etchant containing 1drop HF+25ml HCl .

The microstructure is given in fig. 3-6.

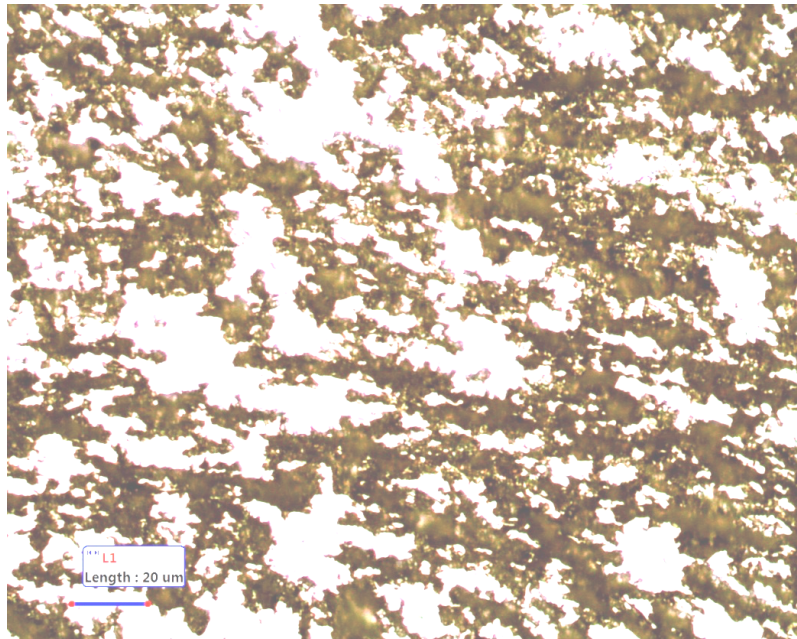


Fig.3 . Microstructure (optical microscope) of 6063 alloy – F conditions.

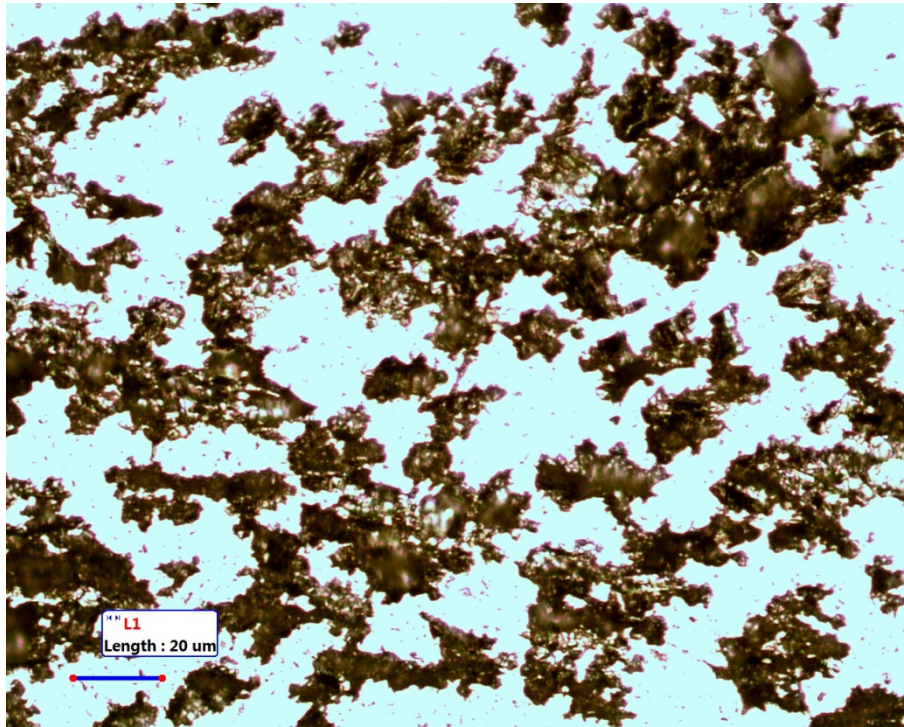


Fig.4 . Microstructure (optical microscope) of 6063-1%SiC alloy – F conditions.

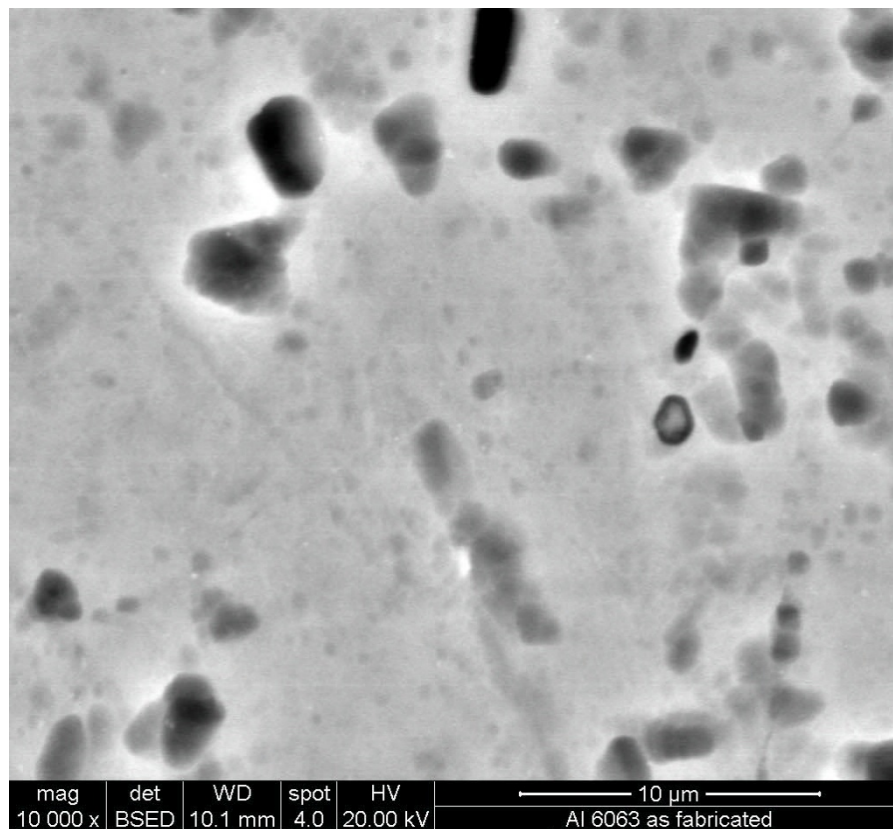


Fig.5 . Microstructure (SEM) of 6063-1%SiC alloy – F conditions.

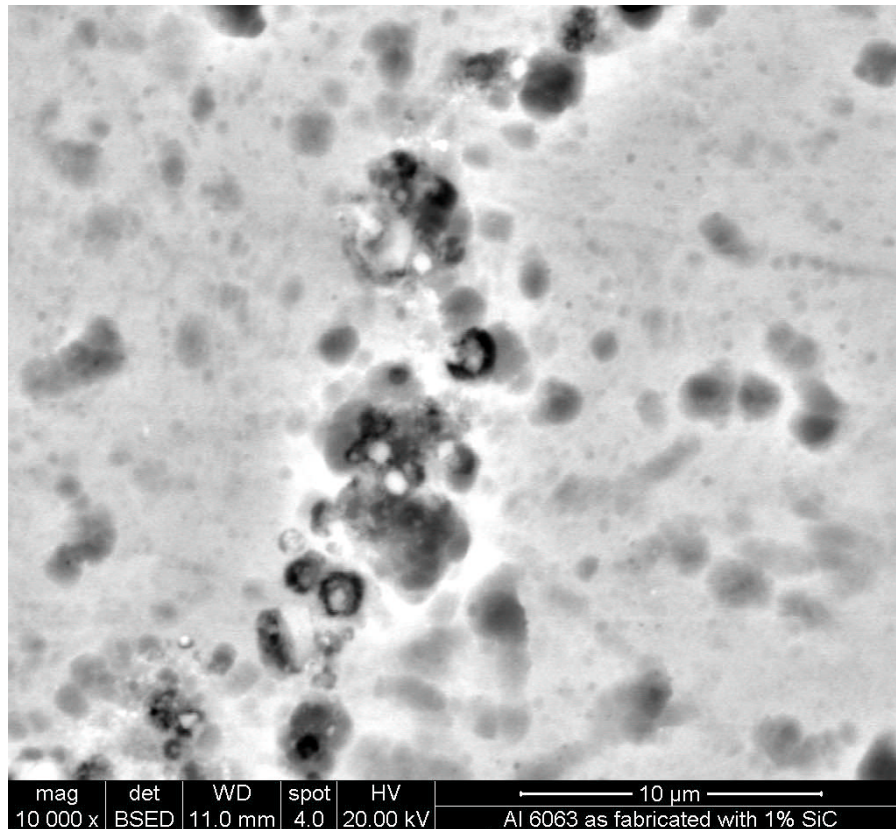


Fig.6 . Microstructure (SEM) of 6063-1%SiC alloy – F conditions.

Note: no evidence of any influence of the reinforcing particles (1% of 40 nanometer SiC particles) on the mechanical properties of the specimens was observed.

Specimens that were produced by EDERTEK (28.03.2010)

Four disks of Aluminum Alloy A356 were examined: 1 and 2 disks reinforced disks (1% of 40 nanometer SiC particles) in conditions of T4 and 15 ,16 not reinforced disks in conditions of T4.

From each disk, 2 specimens for tensile tests were prepared. The tension spencimens were cut out of the disks (fig 1).



Fig.1 . The disk after cutting out tensile specimens.

1. Tensile tests

Specimens with a diameter of 6.0mm and a length of 120mm were prepared from disks, for tensile tests.

The broken specimens after the tests are shown in fig. 2.



Fig. 2- the specimens after the tension tests

Tensile test results (average of 4 specimens) are shown in table 2.

Table 2

Sample	Diameter mm	Tensile Strength , MPa	Yield Strength , MPa	Elongation %	Young Modulus , GPa
A356 Standart	6	290	248	2.3	87
A356+1% SiCnano	6	275	243	1.2	77

2. Hardness Test

Hardness test has been carried out on specimens cut out from disks of the T4-fabricated alloy A356 and MMC A356-1%SiC.

The results of the Brinell hardness test are shown in Table 3.

Table 3

Alloy	Disks number	Hardness HB
A356	15	101
A356	16	103
A356-1%SiC nano	1	104
A356-1%SiC nano	2	104

3. Microstructure test

The microstructure of the specimens was observed using scanning electron microscopy (SEM) on polished sections and fracture area.

The microstructure is given in fig. 2-3.

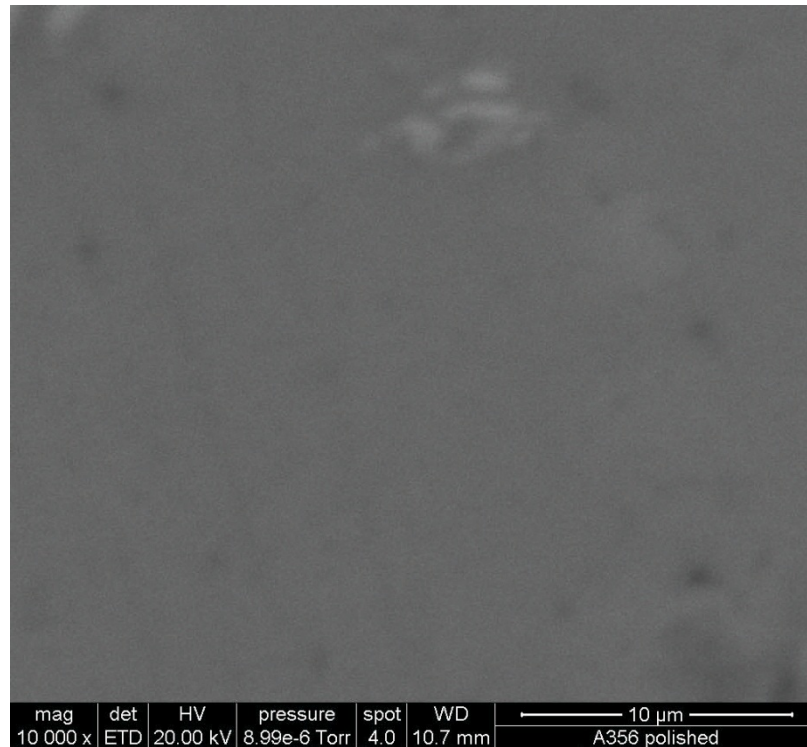


Fig.2 . Microstructure (SEM) of A356 alloy – polished specimen.

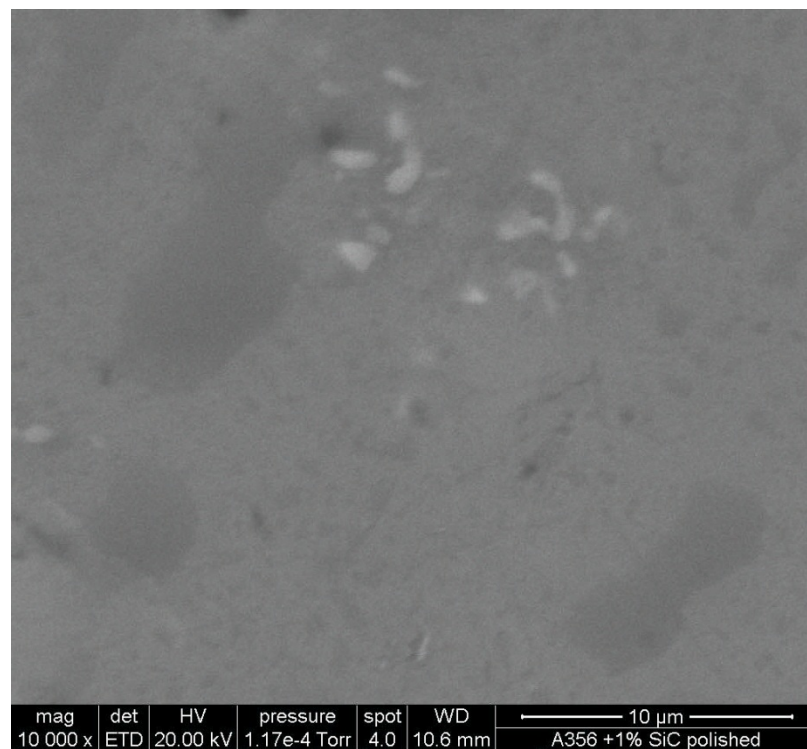


Fig.3 . Microstructure (SEM) of A356-1%SiC matrix alloy – polished specimen.

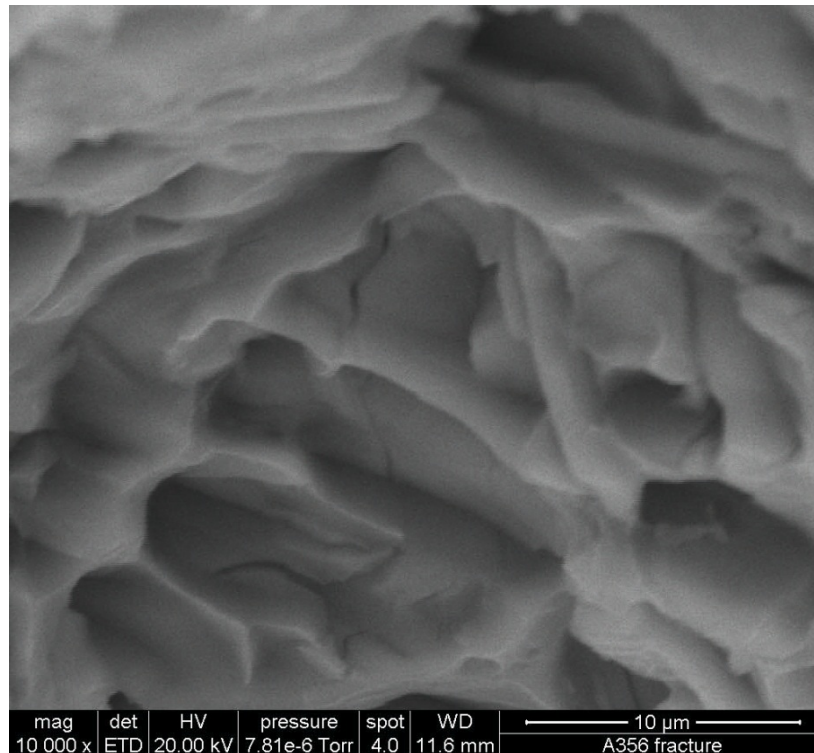


Fig.4 . Microstructure (SEM) of A356 alloy – fracture.

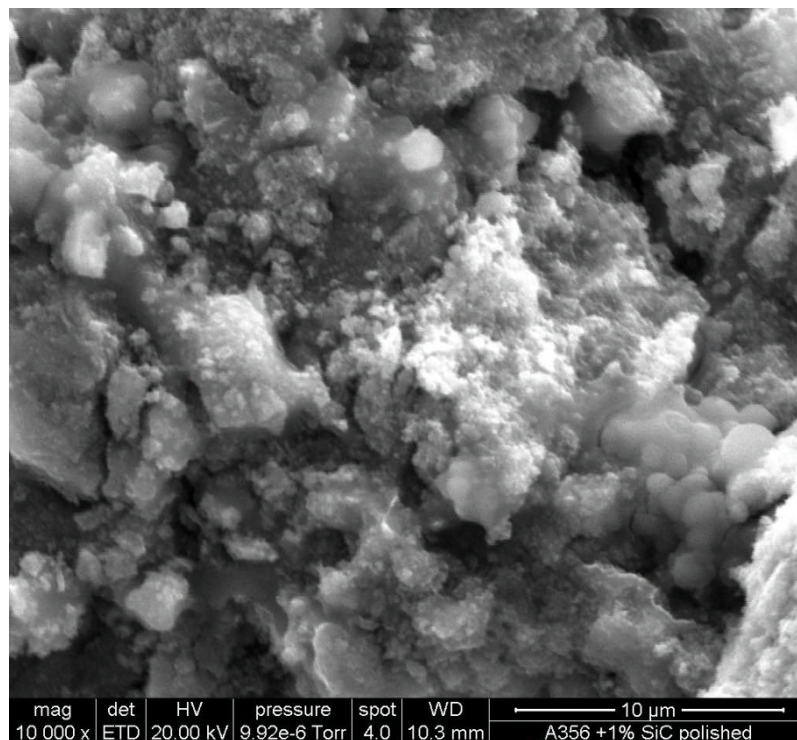


Fig.5 . Microstructure (SEM) of A356-1%SiC matrix alloy – fracture.

Note: no evidence of any influence of the reinforcing particles (1% of 40 nanometer SiC particles) on the mechanical properties of the specimens was observed.