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Research Article

Effects of 600 Microns Particles of Eggshell on Elongation of Zinc-Aluminum (ZA27) Alloy

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Abstract: The study investigates the effects of eggshell particulate on elongation/ductility of ZA27 MMC where eggshell served as particulate reinforcement. ZA27 MMC was produced by melting ZA27 alloy material in a lift-out crucible furnace, and casting the melt with particulate eggshell in sand molds to produce rods of ZA27 MMC. Control sample rods which have no eggshell content were also produced by melting and casting in sand molds. The elongation/ductility of the produced rods was evaluated, and the results show a significant dependence of this property on added particulate eggshell content.
Keywords: Metal matrix composites, ZA27, eggshell, particulate reinforcement, Zinc, Aluminum.

INTRODUCTION

Zinc-Aluminum (ZA) based alloys have been commercially accepted for many years, since the first casting alloy was developed at the New Jersey Zinc Company (Zhu, 2004). The most popular die casting alloy used, ZAMAK 4 was the 898 alloy discovered in their series of alloy development. A new family of hyper-eutectic Zn-Al based alloys with high aluminum and copper contents was developed based on the ZAMAK alloys in North America and China in the 1970s. This new family of the alloy has been candidates as substitutions for traditional bushing alloys, such as bronze and aluminum alloys.

The most common alloys available in this family are the alloys designated as ZA8, ZA12 and ZA27. The alloys are designated 8, 12, and 27 to indicate their approximate aluminum content. They are engineering materials that are well suited to applications requiring high as-cast strength, hardness and wear resistance. While these alloys posses attractive properties, however, continuous research efforts are being made to improve on the properties of the alloy. Such efforts made include the works of: Buras *et al.*, (2017); Zyska *et al.*, (2014); Krajewski, (1998) etc.

One of the important engineering material properties is elongation, which is a measure of the ductility of a material as determined by a tension test; it is the increase in the gauge-length of a test specimen after fracture divided by its original gauge-length. It is referred to as the permanent stretch of a specimen after failure. Higher elongation means higher ductility. Elongation is important in manufacturing - it measures how much bending and shaping a material can withstand without breaking. Tensile testing is used to find many important material properties including elongation.

It is reported in the literature that some ZA alloys show tendency to depreciative properties due to slow solidification in sand mould. One of these depreciative properties is difficulties in the castings feeding-process which simultaneously leads to a decrease of these alloys elasticity (Krajewski, 1998). Generally, efforts are being made to improve the properties of the alloy. Generally, reliable property data of MMC where egg shell is used as reinforcement are scarce. Property data of MMC ZA alloy with egg shell reinforcement are scarcer! In this study, reliable relevant data on elongation properties of ZA27-Eggshell MMC is provided.

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METHODOLOGY

The materials used for the study are zinc aluminum alloy (ZA27) and eggshell. The eggshells were obtained from the shell of eggs laid by golden comet layers chickens. The eggs laid were collected and broken to remove the liquid contents, and the eggshell was dried in the sun for some days. After the eggshells were dried, they were gathered together and grounded in a mortar. The ground eggshells were then sieved into particulate size of 600μm. Previous researches published have used particulate sizes of a few microns; however current trend is exploring particulate sizes between 100 to 850 microns (Barnard *et al.*, 2004). The ZA27 alloy was melted in a lift-out crucible furnace, a volume of about 850ml of the molten alloy was bailed out, and 170 ml of prepared sieved eggshell was added to the molten alloy and stirred vigorously. The mixture of molten alloy and eggshell produced was then quickly poured into a prepared sand mold and cast into rods with 15mm diameter and 200mm in length. A control sample which had no eggshell content was also prepared by casting in sand molds. The cast rods were then machined on lathe machine to produce ASTM E8M-88 standard test pieces for tensile strength, as shown in Figure 1. High Speed Steel (hss) cutting tool was used, with a cutting speed of 305 revolutions per minute. Micrometer screw gauge and vernier calipers were used for measuring the dimensions of the machined samples. Digital Universal testing machine was used to evaluate the elongation/ductility of the produced samples.

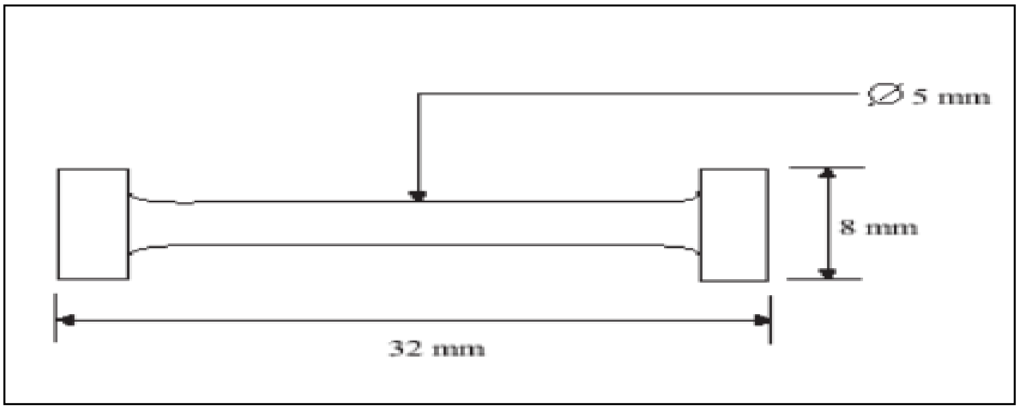

Figure 1: Dimensions of ASTM E8M-88 standard tensile test pieces used

RESULTS AND DISCUSSION

The results of the study are presented in Tables 1, 2, 3, 4 and Figures 2, 3, 4

Table 1: Chemical composition of the ZA27 alloy

Component	**Composition**
Aluminum	25-30
Copper	2.06
Iron	0.065
Magnesium	0.012
Silicon	0.02
Zinc	Rest

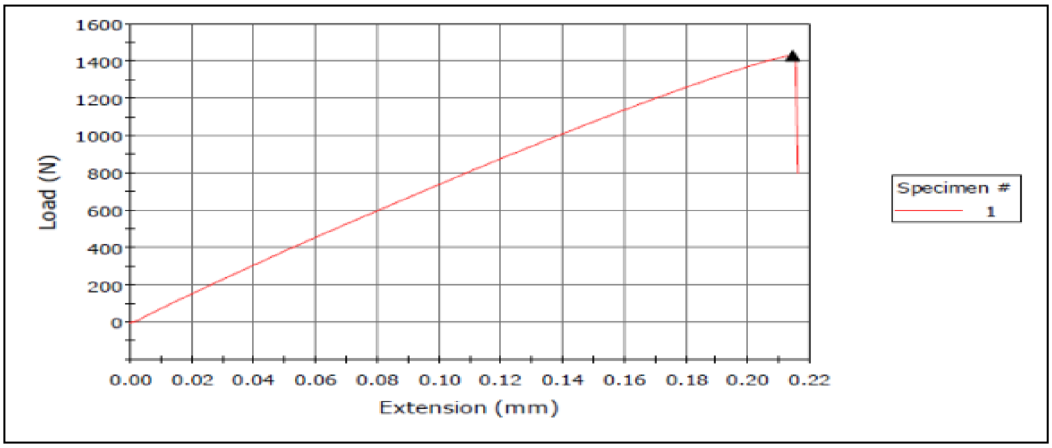

Figure 2: Load-Extension curve for control sample

Table 2: Tensile test result for control sample

	Specimen label	Maximum Load (N)	Tensile stress at Maximum Load (MPa)	Tensile strain at Maximum Load (%)	Load at Break (Standard) (N)	Extension at Maximum Load (mm)
1	ALLUMINIUM Control	1,428.24	72.74	0.21	1,428.24	0.21425
Coefficient of Variation		-----	-----	-----	-----	-----
Maximum		1,428.24	72.74	0.21	1,428.24	0.21425
Mean		1,428.24	72.74	0.21	1,428.24	0.21425
Median		1,428.24	72.74	0.21	1,428.24	0.21425
Minimum		1,428.24	72.74	0.21	1,428.24	0.21425
Range		0.00	0.00	0.00	0.00	0.00000
Standard Deviation		-----	-----	-----	-----	-----
Mean - 1 SD		-----	-----	-----	-----	-----

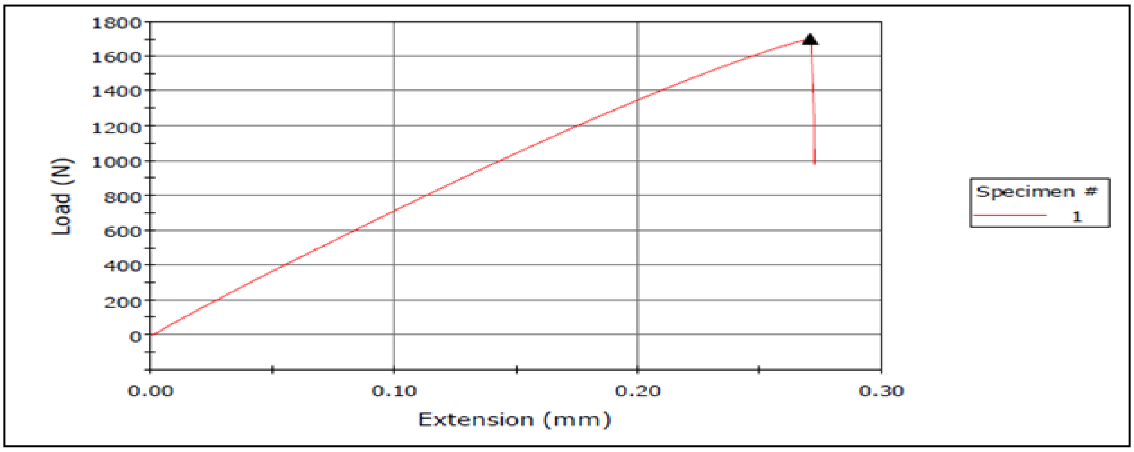

Figure 3: Load-Extension curve for ZA27-Eggshell Composite

Table 3: Tensile test result for ZA27-Eggshell Composite

	Specimen label	Maximum Load (N)	Tensile stress at Maximum Load (MPa)	Tensile strain at Maximum Load (%)	Load at Break (Standard) (N)	Extension at Maximum Load (mm)
1	ALLUMINIUM Egg Shell	1,696.97	86.43	0.27	1,695.81	0.27012
Coefficient of Variation		-----	-----	-----	-----	-----
Maximum		1,696.97	86.43	0.27	1,695.81	0.27012
Mean		1,696.97	86.43	0.27	1,695.81	0.27012
Median		1,696.97	86.43	0.27	1,695.81	0.27012
Minimum		1,696.97	86.43	0.27	1,695.81	0.27012
Range		0.00	0.00	0.00	0.00	0.00000
Standard Deviation		-----	-----	-----	-----	-----
Mean - 1 SD		-----	-----	-----	-----	-----

Table 4: Elongation values for the test samples

Specimen	***Composition***	**Elongation (%)**
Control sample	ZA27	0.21
ZA27-Eggshell Composite	Contains 20 Vol. pct. 600μm Egg shell	0.27

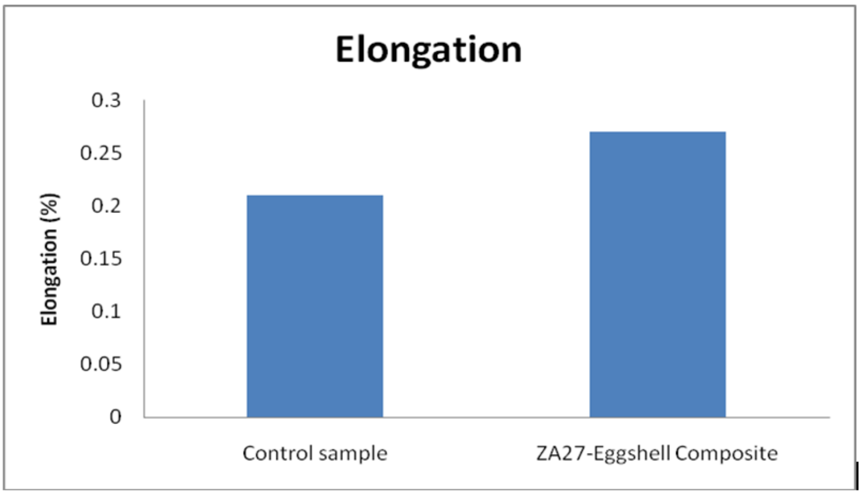

Figure 4: Variation of elongation for the samples

Table 1 shows the general chemical composition of ZA27 alloy. From this table, Zinc is the major element present in ZA27 alloy, and followed by Aluminum which has large portion of about 25-30 % in the ZA27 alloy. Tables 2 to 4 and Figures 2 to 4 present the results of the test of the ZA27 alloy produced. From these tables and figures, the elongation of the control sample is 0.21%, while the measured elongation for the sample containing 20 volume percent (Vol. %) 600µm Egg shell is 0.27%. This shows that addition of 20 vol. %. eggshell particles of sizes of about 600µm increases the ductility of ZA27 composite. This increase in ductility can be explained that it is possible that the added eggshell particles are agents that have increased particle-matrix adhesion in the ZA27 MMC. The higher particle-matrix adhesion can lead to higher elongation of the ZA27 composite.

CONCLUSION

The result of the study shows that eggshell particles of the order of 600 microns increased elongation of ZA27-Eggshell Metal Matrix Composite. It is also inferred that the difference between surface energies of eggshell and ZA27 alloy is high, hence the reason for the observed increased adhesion between eggshell and ZA27 matrix.

REFERENCES

1. Barnard, E., Hager, L., Lichter, J., & McComber, K. (2004). MMC Hammer design review, MIT, Retrieved on 2nd April, 2019 from: https://slideplayer.com/slide/4999295/
2. Buraś, J., Szucki, M., Piwowarski, G., Krajewski, W. K., & Krajewski, P. K. (2017) Strength properties examination of high zinc aluminium alloys inoculated with Ti addition, China Foundry, 14 (3), pp 211–215.
3. Krajewski, W. (1998). Effectiveness of Zn-Al Foundry Alloys Grain-Refinement By The (Al,Zn)-Ti Master Alloy, Solidification of Metals and Alloys, 14, (38), pp. 87-90.
4. Zhu, Y. H. (2004). General Rule of Phase Decomposition in Zn-Al Based Alloys (II) On Effects of External Stresses on Phase Transformation, Materials Transactions, 45 (11), 3083-3097.
5. Zyska, A., Konopka, Z., Łągiewka, M., & Nadolski, M. (2014). The Assessment of Modification of High-Zinc Aluminium Alloy; Archives of Foundry Engineering, 14 (2), 53