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Effect Alumina of Al-Al_2O_3 Composite and Squeeze Casting Pressure on Tensile Strength and Microstructure

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Abstrak-Pengecoran squeeze atau yang sering juga disebut penempaan logam cair adalah proses dimana logam cair dibiarkan membeku dalam cetakan yang diberi tekanan. Penelitian ini bertujuan untuk mengetahui pengaruh tekanan pengecoran squeeze terhadap kekuatan tarik dan mikrostruktur pada AL-AL2O3 komposit. Dalam penelitian ini penulis memvariasikan tekanan 100 Mpa, 120 Mpa, 140 MPa dan persentase berat alumina pada 5%, 10% dan 15%. Sehingga penelitian ini mendapatkan hasil uji tarik paling tinggi pada spesimen dengan campuran berat alumina 10% dan tekanan 140 MPa dengan hasil rata-rata 215 MPa, untuk jarak dendritnya menghasilkan 17,62 µm.. Hal ini menunjukkan bahwa penambahan alumina pada komposit Al-Al_2O_3 akan meningkatkan kekuatan pada penambahan 10% berat alumina

Kata kunci: pengecoran squeeze, Aluminum, Alumina.

Abstract- Squeeze casting or often also called liquid metal forging is a process in which molten metal is inserted in the mold and pressed**.** This study aims to determine the alumina effect and the pressure effect of squeeze casting against tensile strength and microstructure of AL-Al2O3 composite. In this study, used a variation of pressure of 100 MPa, 120 MPa, and 140 MPa and weight percent alumina of 5%wt, 10%wt, and 15%wt. The results of this study showed the highest tensile tests on specimens with a mixture of 10%wt alumina and 140 Mpa pressure with an average yield of 215 MPa, as for his dendrite spacing was 17.62 µm. It is revealed that the addition of an alumina to the Al-Al2O3 composite will raise the strength of 10% by weight of alumina.

Keywords: squeeze casting, Aluminum, Alumina.

1. Introduction

Rapid technological developments give a new idea to produce an innovation through the development of materials. The choice of material for a component generally consists of several aspects such as strength, modulus of elasticity, toughness, impact resistance and resistance to high temperatures. The use of metallic has been developed for industrial products because the metal has mechanical and electrical properties were good. So it is necessary to develop new alternatives to support the metal material in industries such as composites. Composites are materials from a macroscopic combination of two or more different components, has interfaces, including with the purpose of obtaining certain physical and mechanical properties are better than on the nature of each component (Widyastuti, *et al*., 2008). At the material is divided into two, namely the fiber and the matrix material, the matrix material that is often used metal or metal matrix composite (MMC) because it has a strong nature.

Metal Matrix Composite (MMC) is a composite technology with a metal matrix. MMC is usually a blend of ceramic. One of the disadvantages by using a ceramic alloy that is the magnitude of the range of values CTE (Coefficient of Thermal Expansion) metal with ceramic. The magnitude of these differences causes the bonding interface (interface) on these alloys is very low. MMC is then developed composites reinforced with a metal fiber. As one who has frequently developed MMC researchers are Al-based

MMC, with aluminum as the matrix, such as; Al/SiC, Al/TiO_2, Al/BN, Al/TiC, and others (Akrom, *et al*., 2010). To form a composite in need of a process of forming a metal matrix. Methods of making composites there are various ways of casting, powder metallurgy and injection molding. One foundry used that squeeze casting.

Squeeze casting is the casting process in which molten metal is frozen under high pressure using hydraulic power, the process is basically combining the advantages of the process of forging and casting. In squeeze casting process given pressure the plunger to produce products that have good quality. Pressure greatly affects the outcome of the finished product. This is because the greater the pressure, the propulsive force to push the molten metal bigger so as to cause the speed of suppression of the higher and the air can more quickly get out before the molten metal solidifies and defects porosity on the outcome of the finished product will be reduced (Wiyono, *et al*., 2000).This study aims to determine the alumina effect and the pressure effect of squeeze casting against tensile strength and microstructure of AL-Al_2O_3 composite.

2. Research Method

Materials :1.Aluminum scrap
2.Alumina

2.1. Research procedure

Research procedures conducted are:

1. Prepare Equipment and Materials
2. Considering the weight of scrap aluminum and alumina with a composition of 5%, 10%, 15% by weight of alumina
3. Heat up the mold to a temperature of 200°C
4. Melt aluminum scrap
5. Incorporate alumina and stirring
6. Pour the solution of al-Al_2O_3 into the mold
7. Pressing the fluid with a pressure of 100 MPa, 120 MPa, 140 MPa
8. Waiting for the frozen metal.
9. Remove the specimen from the mold
10. Make a tensile test specimen and microstructure
11. Test specimens

3. Result and Discussion

3.1. Tensile Test Results Analysis

Tensile stress testing conducted at the Laboratory of Materials Faculty of Engineering, Wahid Hasyim University was using test equipment Gotech. From the results of the tensile test specimens can be seen in Figure 1.

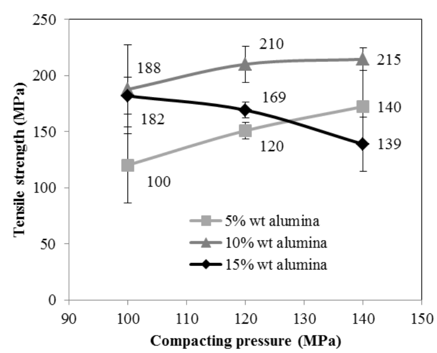

Figure 1. Relationship Graph pressure with tensile strength.

Figure 1 shows the results of tensile test on specimen of 5% wt alumina with a compaction pressure of 100 MPa, 120 MPa, 140 MPa tensile stress has a row are 120 MPa, 151 MPa, 172 MPa. In a specimen of 10% wt alumina with a compaction pressure of 100 MPa, 120 MPa, 140 MPa tensile stress has a row are 188 MPa, 210 MPa, 215 MPa. In a specimen of 15% wt alumina with a compaction pressure of 100 MPa, 120 MPa, 140 MPa tensile stress has a row are 139 MPa, 169 MPa, 182 MPa.

From the results of the tensile test, it can be said to be the highest tensile strength obtained on specimens 10% by weight of alumina with a compaction pressure of 140 MPa. This shows that the addition of alumina if more than 10% wt alumina, the tensile strength of the specimen will decrease. Even at 15% wt an alumina content, the tensile strength decreases with increasing compaction pressure.

3.2. Photo analysis of microstructure

Microstructure tests conducted at the Laboratory of material, Faculty of Engineering, Wahid Hasyim University was using microscopy tool, the purpose of testing is to determine the distance of the dendrites of the photo specimen. The measurement results within the dendrites on the microstructure images can be seen in the following discussion:

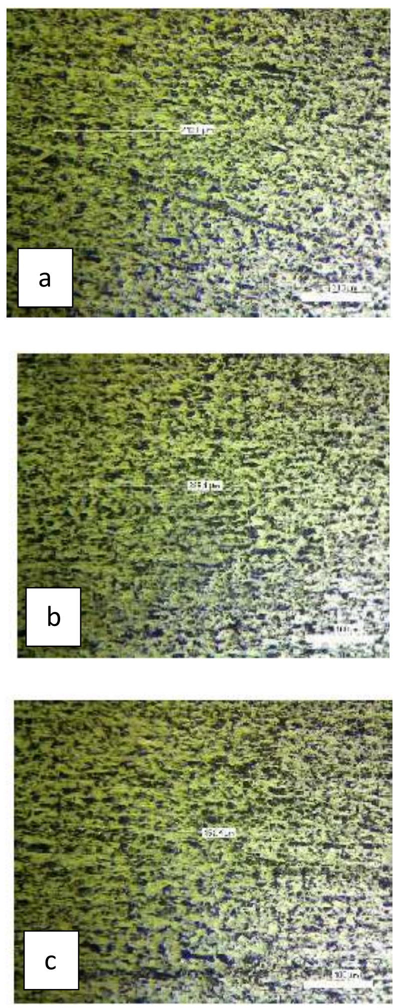

Figure 2 Photo microstructure specimens containing 5% wt alumina with a compaction pressure, a. 100 MPa, b. 120 MPa, and c. 140 MPa.

Figure 2 shows the images of the microstructure of the specimens with a content of 5% by weight of alumina. From this photo measured distance of dendrites. Distance dendrites on each compaction pressure of 100 MPa, 120 MPa, 140 MPa, respectively are 26 776 μm, 24 025 μm, 18,083 μm. With the increasing compaction pressure then the closer the distance of the resulting dendrites. This is according to research Nurkholiq, et al (2013).

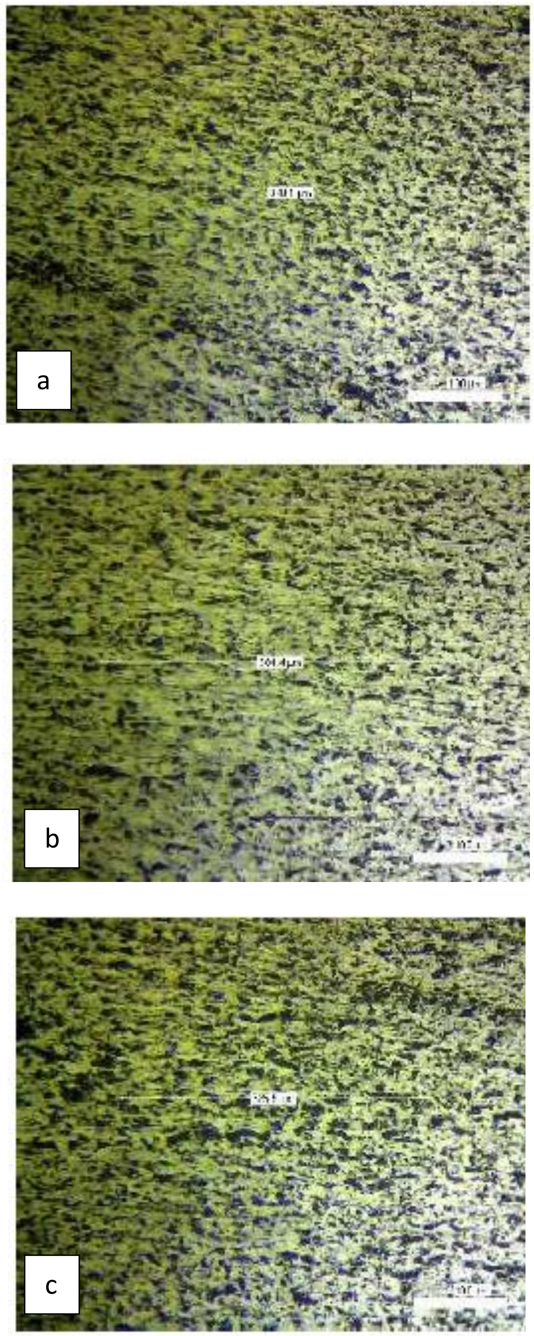

Figure 3 Photo microstructure specimens containing 10% wt alumina with a compaction pressure, a. 100 MPa, b. 120 MPa, and c. 140 MPa.

Figure 3 shows the images of the microstructure of the specimens with a content of 10% by weight of alumina. From this photo measurable distance of its dendrites. Distance dendrites on each compaction pressure of 100 MPa, 120 MPa, 140 MPa, respectively are 21 689 μm, 19 231 μm, 17.62 μm. With the increasing compaction pressure then the closer the distance of the resulting dendrites. This indicates the higher compaction pressure also condense specimens and according to research Nurkholiq, et al (2013).

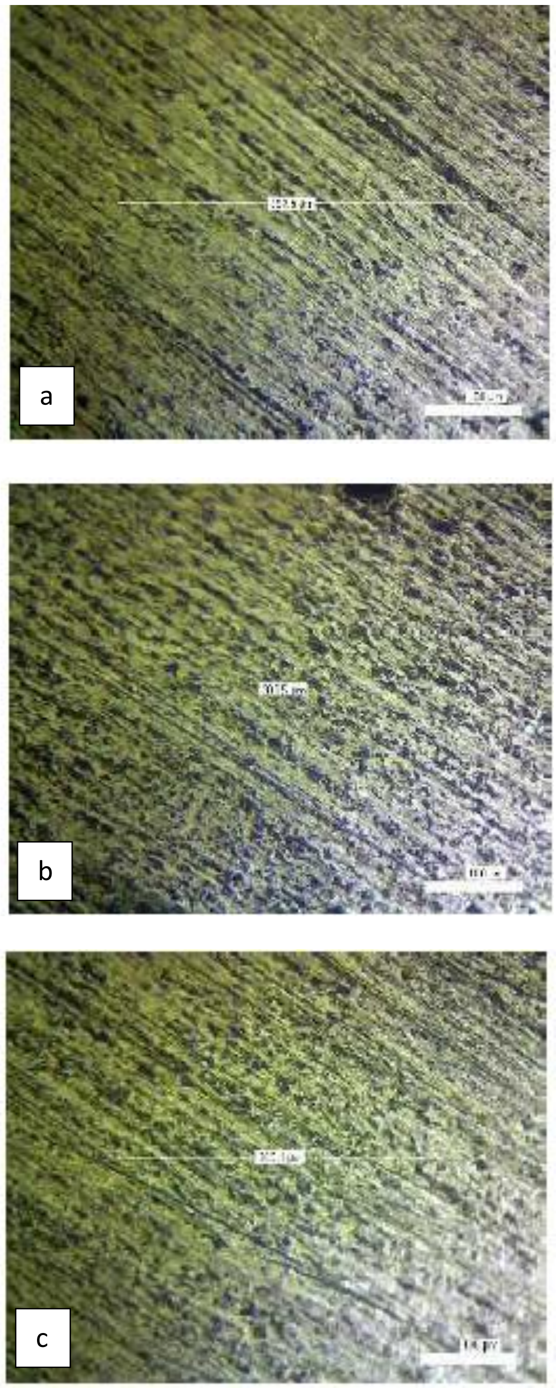

Figure 4 Photo microstructure specimens containing 15% wt alumina with a compaction pressure, a. 100 MPa, b. 120 MPa, and c. 140 MPa.

Figure 4 shows the images of the microstructure of the specimens with a content of 15% by weight of alumina. From this photo measured distance of dendrites. Distance dendrites on each compaction pressure of 100 MPa, 120 MPa, 140 MPa, respectively are 29.8 μm, 17 027 μm, 16 665 μm. Distance dendrites in specimens alumina content of 15% by weight are more dense than others, but its strength decreases. If considered more clear, the content of 15% by weight of alumina are holes alumina. This shows that alumina cannot be fused with aluminum so that if too much alumina content will be chipped. From the measurement results within the dendrites, it can be graphed as in Figure 5.

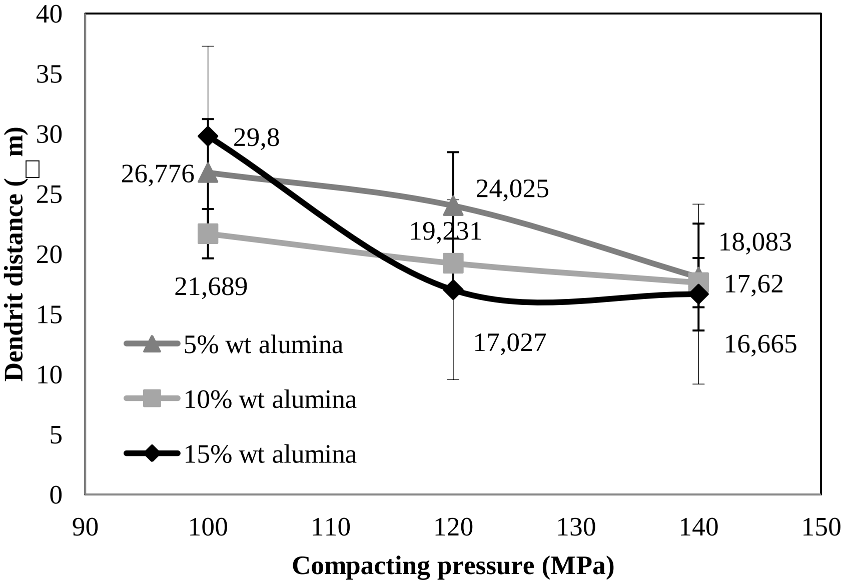

Figure 5 Relationship between compaction pressure with the dendritic

Figure 5 shows that most low dendrite spacing owned of the content 15 wt% alumina, but a sharp decline in compaction pressure of 100 MPa to 120 MPa makes the tensile strength decreased. This shows that the alumina content of 15 wt% are unstable and tend to be easily separated from the aluminum matrix. While distance dendrites on the content of 10 wt% alumina relatively steady decline. It is equal to the distance dendrites on the content of 5 wt% alumina, dendrites distance is still higher than the content of 10 wt% alumina

4. Conclusion

The results of the highest tensile tests on specimens content of 10 wt% alumina with compacting pressure of 140 MPa. This is due to alumina can be attached to the aluminum and not easily separated from the matrix so that it can be a solid material.

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