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# Fluidity Characteristics of A201 and A206 Al-Cu Alloy

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## Abstract

Al-4.5Cu alloys are widely used in aerospace industries due to their low weight and high mechanical properties. This group of aluminium alloys is known as 2xx series and exhibits the highest mechanical properties however this alloy is known to suffer from feedability and high tendency for hot tearing. Al-Si alloys (3xx) have improved fluidity and better feedability particularly by several modifications such as Ti, B or Sr. Eutectic temperature is decreased and mechanical properties can be enhanced. Yet, the strength values of this alloy group cannot reach the values of 2xx series. Therefore, in this study, the effect of Ag addition on the fluidity of Al-4.5Cu alloy has been investigated. Standard size spiral mould was used. The casting temperature was selected to be 770°C. Five castings were made and Weibull statistical approach was used to evaluate the results. In addition, coating of the die with BN was also investigated. It was found that Ag addition and BN coating of the die revealed the most reproducible, reliable and high fluidity values.

**Keywords:** Al-Cu, 2xx, Casting, Fluidity, Mould Coating

## 1. Introduction

Aluminium casting alloys have wide range applications in industry, especially in automotive and aerospace. These industrial applications require high mechanical properties, corrosion resistance and castability. In these sense, 3xx series Al-Si-Mg casting alloys are chosen often due to their great castability [1, 2]. Silicon plays an important role particularly having high thermal properties increases the fluidity. However, morphology of Si is needle-like and thereby decreases the mechanical properties. Strontium modification is applied in order to alter this coarse structure to finer fibrous form. One of the main actions to increase fluidity of molten aluminium is modification with strontium or antimony [3]. Yet, the tensile properties of 2xx alloys exhibit the highest values [4, 5, 6, 7, 8]. 206 alloy that contains 4.5Cu is modified with Ag to obtain even higher mechanical properties. Lui [5] studied the effect of iron content on the tensile properties of A206 alloy and concluded that Fe content has to be lower than 0.17

wt% in order to obtain high mechanical strength. Mose [9] found that high Fe levels decreased fluidity of Al-Si alloys. Taghaddos [10] show that formation of Fe-intermetallics significantly decreases fluidity. Colak [11] looked into the cleaning of the Al4Cu with and without the use of fluxes. The fluidity of this alloy group play a key role when thin walled materials are needed to be produced in automotive or aerospace industries. Adding Ag causes solution hardening and increases durability. Ag in A201 alloys, not only effects durability positively but also effects fluidity. Ravi [12] has carried out an extensive review on fluidity of cast alloys. Colak [13] used a new mould design to investigate the fluidity characteristics of A356 alloy.

Dolata-Grosz et. Al [7] investigated influence of addition elements on fluidity of 226D (Al10Si2Cu) aluminium cast alloy and found out that addition of Ti, B and Sr improve fluidity behaviour. At the other study, Dolata-Grosz et. Al [14] found out that influence of composite materials (e.g. silicon carbide particles and glassy carbon particles) on molten metal fluidity is negative.

Di Sabatino [15] had also shown that oxide inclusions decrease fluidity. Timelli [2] showed that increased scrap ratio in high pressure die casting decreased fluidity due to increased oxide entrainment. Sowa [16] used numerical analysis to investigate the solidification parameters on fluidity such as velocity of liquid, pressure head and temperature of the melt. Di Sabatino [17] correlated the experimental results of spiral fluidity tests with the simulation and found a good correlation for A356 alloy.

## 2. Experimental

In the experiments, A201 (Al-4.5Cu-Ag) and A206 (Al-4.5Cu) alloys were used and the chemical analyses of these alloys are given in Table 1.

Table 1.

The chemical compositions of A201 and A206 aluminium alloys

	Si	Fe	Cu	Mn	Mg	Ti	Ag	Al
A201	0,22	0,08	4,5	0,25	0,20	0,10	0,87	Rem.
A206	0,32	0,10	4,7	0,39	0,16	0,24	-	Rem.

Electrical resistance furnace was used to melt 1 kg of the alloys. These alloys were cast into spiral die mould at 770°C as shown in Figure 1. Die temperature was kept constant at 230°C. Tests were repeated five times and Weibull statistic was used to evaluate the results. Additionally, the die was coated with BN and the effect of coating on the fluidity was investigated.

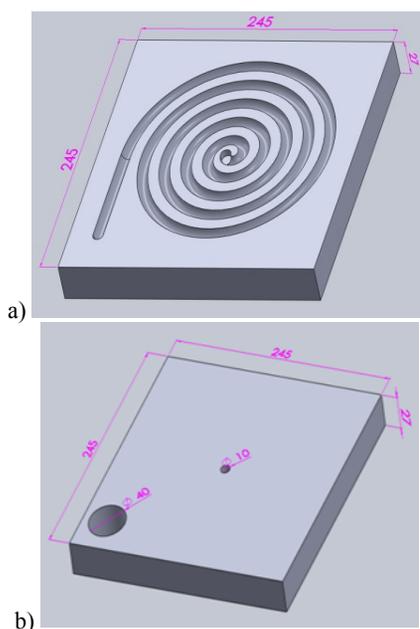


Fig. 1. a) The bottom of the mould b) The top of the mould c) Spiral shell mould

## 3. Results and discussion

After castings were complete, the lengths of fluidity were measured. The effects of mould coating on A201 and A206 were given in the Figure 2. As can be seen, 206 alloy do not appear to be affected by the coating. Both test results of BN coated and non-coated die spiral fluidity results lie on top of each other (Fig 2b). On the other hand, Ag added 206 which is known as 201 alloy reveals better fluidity when the die is coated with BN.

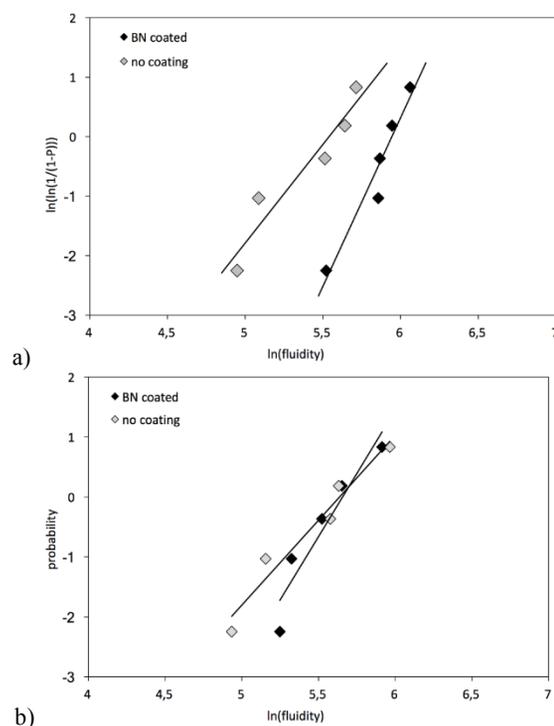


Fig. 2. Weibull analysis of fluidity results with and without BN coating on the mould (a) A201, (b) A206 alloy

In Figure 3, fluidity results of both alloys were compared. It was found that when the mould was coated with BN, 201 has better and more reproducible fluidity results compare to 206 alloy. However,

when the die is not coated, both alloys have similar fluidity characteristics which is lower than the BN coated test results.

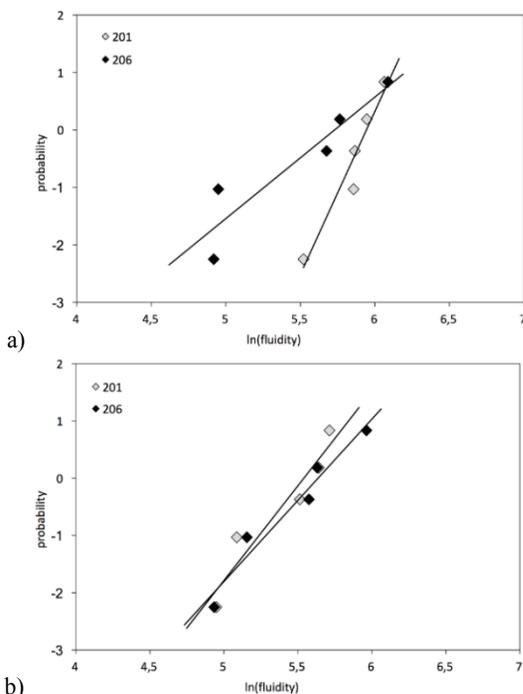


Fig. 3. Comparison of fluidity results of A201 and A206 (a) with BN coating, (b) no coating

Table 2.

Characteristic fluidity results measured from Weibull analysis

Alloy	Condition	Fluidity (mm)
201	BN coated	381,3
201	No coating	254,1
206	BN coated	240,4
206	No coating	283,3

Table 2 summarises the characteristic fluidity lengths of 201 and 206 alloy with and without BN coating of the die. These values were calculated by the beta value of Weibull analysis. On average, regarding the spiral tests, the fluidity of 201 alloy is 317,7 mm and this value is 261,9 for 206 alloy. It can be seen that there is approximately 60 mm difference in the fluidity length of 201 and 206 which indicates that Ag has additional positive effect on Al-Cu alloys.

Application of BN coating on die mould has significant effect on fluidity of 201 alloy. The difference is around 130 mm. On the other hand, statistically, 206 has not seen to be affected by coating of the mould.

Table 3.

Weibull modulus of test results

Alloy	Condition	Weibull Modulus
201	BN coated	5,7
201	No coating	3,3
206	BN coated	4,2
206	No coating	2,8

In Table 3, Weibull modulus results are given which indicates the reliability and reproducibility of the fluidity measurements. It can be seen that 201 alloy cast into BN coated spiral mould has the highest modulus with 5,7. On the other hand 206 on non-coated mould shows the highest scatter of results with a Weibull modulus of 2,8.

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