Investigation into effect of silicon morphology on surface roughness while machining Al-Si-Cu-Mg alloy

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ABSTRACT – Surface roughness is one of the key measures in manufacturing that describes machined surface integrity. In this research work, the effect of silicon morphology on surface roughness when turning Al-11%Si-1.8%Cu alloy and Sr-containing alloys was investigated. The experiments are carried out under oblique dry cutting conditions using a PVD TIN-coated insert at three cutting speeds of 70, 130 and 250 m/min, feed rates of 0.05, 0.1, 0.15 mm/rev, and 0.05 mm constant depth of cut. The result released that surface roughness decreased with adding 0.04 wt.% Sr to casting. The surface roughness values reduce with cutting speed increment from 70 m/min to 250 m/min. Also, the surface finish deteriorated with increase in feed rate from 0.5 mm/rev to 0.15 mm/rev.

1. INTRODUCTION

Machining is one of the most important activities in manufacturing industry, and plays a central role in modern manufacturing. Modeling with the help of experimental results forms an important part in the investigation of the complex dynamic mechanisms of machining operations [1]. Surface roughness is one of the important machinability parameter. It can be adjusted to achieve optimum result and aid to decrease costs. It was in the 1960s that researchers first showed that a high quality machined surface can be achieved by looking at all the aspects of the problem, including microstructure studies. Aluminium-silicon alloy have been increasingly used in aerospace industry and advanced arm systems such as satellite bearing, automobile and aerospace [2]. They are being considered as a replacement material for the conventional alloys in many engineering industries [3]. The reason for the wide acceptance of the Al–Si alloys can be found in the good thermal conductivity, low expansion coefficient, machinability and weldability [4]. Several experimental results have been reported describing the use of grain refiners or modifiers to obtain a fine-grained microstructure of eutectic Al–Si alloys [5]. Tomac and Tonnessen conducted a series of machining tests on Al-Si and concluded that the higher percentage of hard particles extremely affect the tool wear. They also found that surface roughness decreased with increasing cutting speed [13]. However, there is limited literature about the effect of different additives on machinability of aluminum silicon die casting alloy. The purpose of this study is to experimentally investigate the effect of cutting conditions on machining surface of Al-11%Si andAl-11%Si- 0.04% Sr die cast alloys.

2. METHODOLOGY

The melted materials were prepared by using an induction furnace. The melt temperature was maintained at 750-760°C for a period long enough to allow for complete melt homogenization. The molten alloy was then poured at a temperature of 730 ± 5°C into the permanent mold. Turning tests carried out with CNC turning machine ALPHA 1350S 8.3 kW power drive and 6000 rpm maximum spindle speed. Details of the cutting tool is given in Tables 1

Table 1 Details of the cutting tool.

Tools/grade	Composition catalog	ISO number
KU10	TIN	VBGT110302F

3. RESULT

Turning investigation on untreated and Sr-treated Al-11%Si alloys shown that surface roughness values increased with feed rate increment, while it decreased with increasing cutting speed for both workpiece materials. Fig 1 shows value of surface roughness at cutting speed of 250 m/min. The result shows that Sr-treated Al-11%Si alloys have poor surface roughness compared to Al-11%Si alloy at all conditions. This can be related to the shape of silicon after adding strontium (Sr) which affects the ductility of workpiece.

Figures 2 (a) and (b) show that Sr addition can change the silicon shape from flake to lamellar. In addition plastic deformation of the soft phase in the cutting zone and the building up at the cutting tool edge are pronounced that increased surface roughness of workpieces after turning operations.

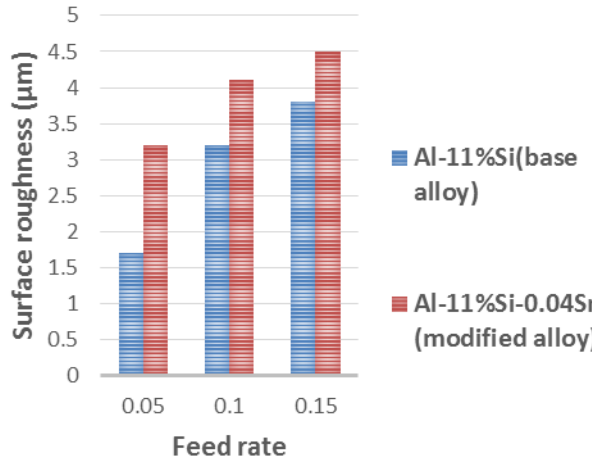

Figure 1 Value of surface roughness at cutting speed of 250 m/min and different feed rates.

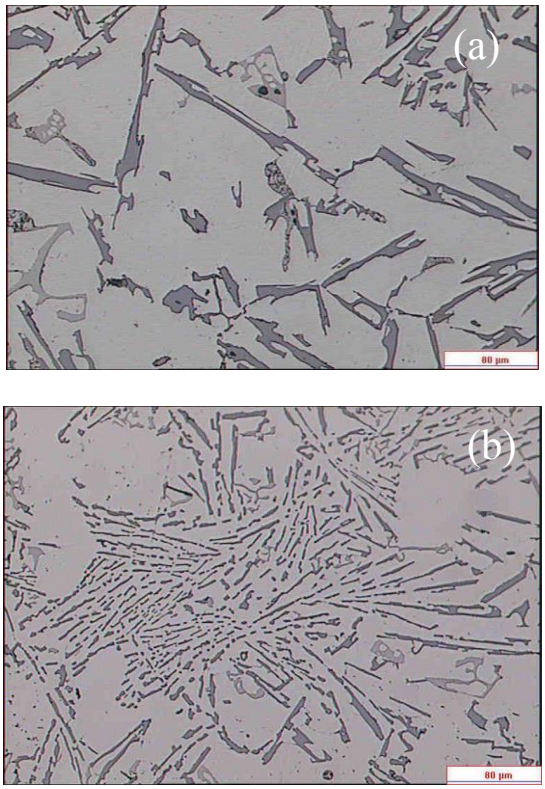

Figure 2 Microstructure of workpieces with 100X magnification (a) Al-11Si-1.8Cu Non modified, (b) Al-11Si-1.8Cu 0.04 % Sr modified.

4. SUMMARY

Different surface roughness are observed in both of workpieces on the dissimilar cutting condition.

a) It was found that surface finish improved with increasing cutting speed due to rising temperature and decrease in the BUE formation and quick breakage of it from tool during machining workpieces.

b) Experimental results show that Sb-treated Al-11%Si have poor surface roughness compared to untreated condition in the all of cutting conditions.

5. REFERENCES

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