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Machinability of modified AlSi7Mg0,3 alloy

Nataša Náprstková[1], Jaroimír Cais[2]

[1]Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, 400 96, Ústí nad Labem, CZ, phone: +420 475 285 513, e-mail: naprstkova@fvtm.ujep.cz
[2]Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, 400 96, Ústí nad Labem, CZ, phone: +420 475 285 547, e-mail: cais@fvtm.ujep.cz

Abstract. Al Alloys have an important position in the industry, mainly in the automotive and aerospace industries. One important group is silumins (Al-Si alloys). Al-Si alloys are the leading casting alloys based on aluminum. Machining of aluminum alloys is currently frequently used and it is an important area of production. This paper deals with an experiment that was conducted at the Faculty of Production Technology and Management, University of Jan Evangelista Purkyně in Ústí nad Labem, where alloy AlSi7Mg0,3 was experimented upon. Samples were made for processing from the master alloy AlSi7Mg0,3, subsequently unmodified and modified of Sr, Ca and Sb. This paper describes the evaluation of hardness, chip and tool wear in terms of how modification by Sr, Ca and Sb may affect analytical values.

Key words – Alloy, Al-Si, modification, machining, hardness, chip

1. Introduction

Machining of aluminum alloys is now often used in the technological process. This also applies to bellow eutectic silumins. AlSi7Mg0.3 alloy is widely used in the automotive industry as casting wheels for passenger cars or parts of engines (MICHNA Š. 2005, MICHNA Š. 2008).

This article describes experiments that were conducted at FPTM with AlSi7Mg0,3 alloy (masteralloy). (MICHNA 2005, MICHNA, KUŚMIERCZAK 2008).

Modification of aluminum alloys in the current production has a great importance, because the use of aluminum alloys is constantly growing and modification improves their utility properties. (WEISS V. 2012a, WEISS V. 2012b).

The aim of the experiment was to analyze the possible effect of modification by Sr, Ca and Sb on the tool wear and chip, because tool life of the cutting tool and chip is one of the important indicators of economic production. (BILÍK O. 2001, CZÁN R. 2006, NOVÁK M. 2009).

2. Conditions of experiments

For each experiment three to four castings of each alloy were made, which was an experiment carried out and subsequently analyzed. It was therefore master alloy AlSi7Mg0,3 without modification, further master alloy AlSi7Mg0,3 subsequently modified with 0.04% Sr, master alloy AlSi7Mg0,3 subsequently modified with 0.05% Ca and master alloy AlSi7Mg0,3 subsequently modified with 0.05% Sn.

Test samples were machined on a lathe Emco Mat - 14 S, which is available on the FVTM. Set cutting conditions were based primarily on the type of machine and tool. Used cutting tools were plates

PRAMET DCMT 070202 E – UR and based on the material to be machined and used machine and tool was set a cut depth of a_p=*1 mm* and feed per revolution *f=0,12mm.rev*$^{-1}$. Cutting speed v_c was necessary to adapt the options of used lathe, particularly its maximum rotation speed *n*. (MÁDL. J. 2012).

On the basis of possibilities and calculations the cutting speed for actual machining v_c was adapted to used lathe for the resulting value v_c=*200.96 m.min*$^{-1}$. At this speed v_c, the rotations were *n = 1066.min*$^{-1}$ for diameter *60 mm* and *n = 4000.min*$^{-1}$ for diameter *14 mm* (MICHNA Š., KUŚMIERCZAK S. 2008, MICHNA Š. NAPRSTKOVÁ N. 2011). All the working conditions for the machining are set to achieve the maximum load inserts. (NÁPRSTKOVÁ N. 2012).

4. Measurement of inserts wear

After processing the samples it was evaluated inserts wear. This measurement was performed using the microscope Olympus SZX 10 (MICHNA Š., NÁPRSTKOVÁ N. 2011).

Parameters which were measured (Fig. 1) there were back wear VB, maximum back wear VBmax and wear in the peak VBc. (ŠEBELOVÁ 2013, VENZARA 2012). For measurement the software QuickPHOTO CAMERA 3.2 was used.

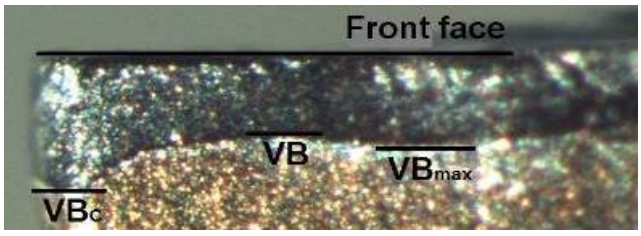

Fig. 1 The principle of measurement of wear values of cutting plate (insert).

Source: own work

All castings were machined during one type insert and the same cutting conditions (see above). In Fig. 2. is a graph showing the average values of wear VB analyzed for each alloy. The graph shows that the subsequent modification has a small, but positive influence (measured in terms of a small parameter) on the tool wear parameter VB. The difference is smallest for the modification by Sb. The best effect for wear VB had the modification by Ca.

In Fig. 3 is a graph showing an average VBmax values for the same. The graph also shows that the subsequent modification has small, be a positive influence for the tool wear parameter VBmax. The difference is smallest for modifying by Sr. The best effect again, had modification by Ca.

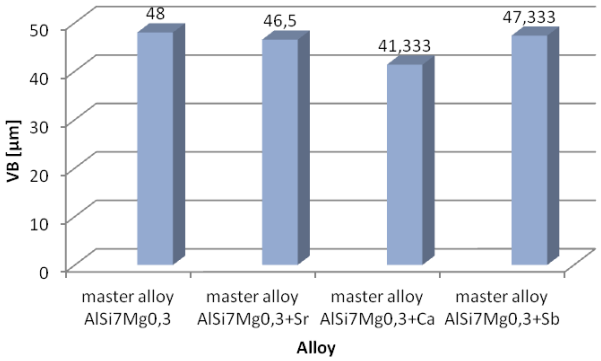

Fig. 2 Average wear VB for each alloy.

Source: own study

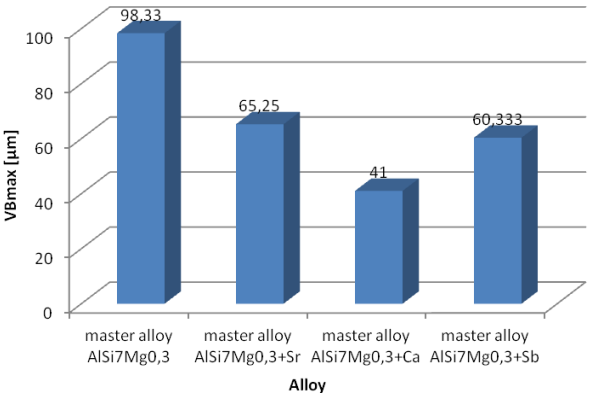

Fig. 3. Average wear VBmax for each alloy.

Source: own study.

In Fig. 4 is a graph showing an average VBc values for the same. The graph also shows that the subsequent modification has small, but a positive influence for the tool wear parameter VBc. VBmax at the wear again had modifications by Ca. There is an extreme for modification by Sr, which was caused by a defect in one of the castings.

From the comparison wear for each group of castings, it is clear that the modified alloy AlSi7Mg0 3 thus has a positive effect on tool wear (wear is less). Possible variations are disclosed above.

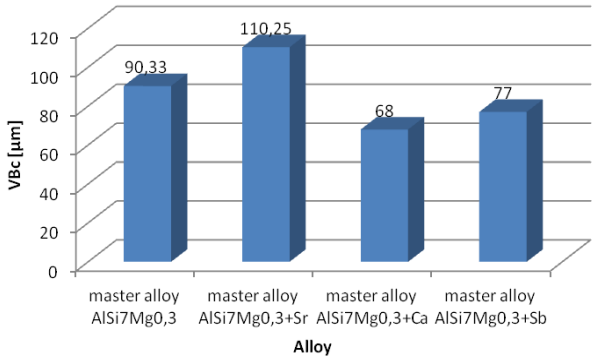

Fig. 4. Average wear VBc for each alloy

Source: own study.

5. Evaluation of chips

Within the experiment chip shape and size were also evaluated. When the machining of all samples formed segmented arched divided chip (Fig. 5), a chip had a tendency to spin into spirals.

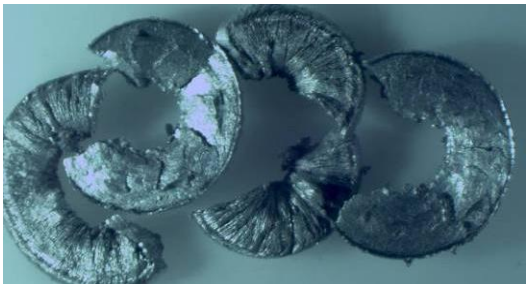

Fig. 5 Example of chip shape from the experimental alloy machining.

Source: own study.

In Fig. 6 is a graph that summarizes the average values of the chips for all machined castings subsequently modified by Sr, Ca and Sb.

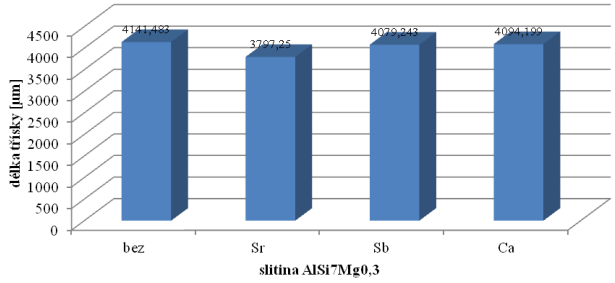

Fig. 6. Comparison of the lengths of the chips in the frame of all castings without and with seq. modif. by Sr, Sb and Ca.

Source: own study.

From this comparison, it is clear that the subsequent modification had minimal but still slightly positive effects on the size of the chip, because the machining of the subsequently modified alloy formed slightly smaller chips.

6. Summary and conclusions

For the experiments casts were made from the master alloy AlSi7Mg0,3 and then from these alloys which had been modified by Sr, Ca and Sb.

All experimental castings are machined under the given cutting conditions. An important limiting condition was the cutting machine, which is for this purpose at available at FPTM and which can be used up to 4000 rpm. Consequently, it was not possible to prevent the formation of build-up on the inserts, which was formed in different ranges and sizes for practically all machining of the experimental castings. Build-up was expected due to the fact that Al alloys have a big inclination on this effect.

On the used plates the parameters of wear VB, VBc and VBmax were measured. From the measured values it was possible to conclude that for modifications the difference was not so large (ligature AlSi7Mg0,3 was always compared without further modifications and this master alloy was subsequently modified by Ca, Sr and Sb), but it is possible to conclude, albeit slightly, that the insert wear was usually smaller for alloys subsequently modified. This difference was most pronounced for modified castings by Ca, therefore there were minimum values of inserts wear. The smallest, almost imperceptible, this difference was for the modification by antimony, therefore, this modification was not almost appeared.

In the experiment the size (length) of chips and its shape was also evaluated. For all machined alloys, whether treated or untreated, it was true that the chips had always the divided spiral shape and were not so great. The shape of the chip was relatively advantageous in terms of the usual requirements for machining. For each cast 30 pieces of chips were measured. The longest splinter chip had the master alloy AlSi7Mg0,3 without the next modification. Generally, on the basis of experiments the modification has a positive effect on the shape of chips. Chips formed smaller, though in some cases the differences were minimal.

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