FFW 2025
Fracture Fatigue and Wear

The influence of Zr addition on surface texture and tribological characteristics of AlSi5Cu2Mg alloy

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Abstract

The work presents the characteristics of the AlSi5Cu2Mg alloy/the alloy with the Zr addition, and manufacturing process. Prepared samples were studied to assess of the machined surface layer. For this purpose, a confocal microscope (surface topography) and a scanning electron microscope (surface morphology) were used. Then, tribological tests were carried out to check how the Zr addition influences on the tribological characteristics. Studies of the operational surface layer were carried out to assess the worn surface topography and the characteristics of wear traces. Based on the results obtained, conclusions and further research work were formulated.

Materials and Methods

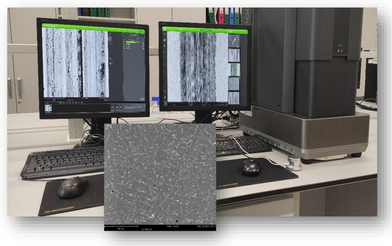
For the experimental purposes, three types of samples were prepared - alloys: AlSi5Cu2Mg (A) with the addition of 0.10 (B), and 0.20 (C) wt. % Zr were manufactured.
The alloys were manufactured by gravity casting into a metal mold with temperature 200 ± 20 °C. The primary alloy AlSi5Cu2Mg was melt in an electric resistant furnace. Zirconium in the form of AlZr20 master alloy was added at 780 ± 5 °C. For each alloy, the heat treatment (HT) with following parameters was used:

- solution heat treatment at 500 ± 5 °C for 6.5 hours;
- quenching into water with temperature of 80 – 90 °C;
- artificial aging at 250 ± 5 °C for 4 hours with subsequent air cooling.

The research methodology with scope of studies was presented below.

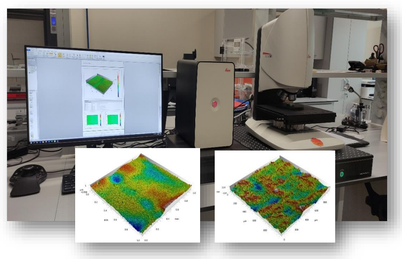
SURFACE CHARCTERISTICS

SCANING ELECTRON MICROSCOPE SEM



machined surface morphology

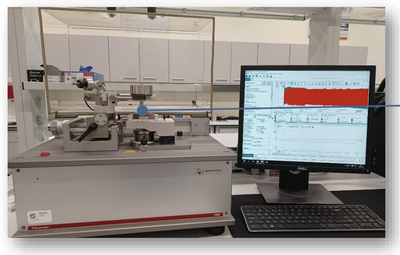
CONFOCAL MICROSCOPE CM



machined surface topography

TRIBOLOGICAL TESTS

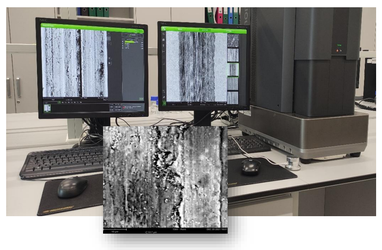
TRIBOTESTER TRB



– friction coefficient
– wear intensity

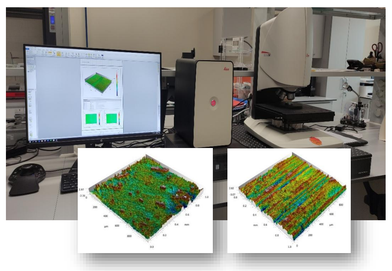
SURFACE CHARCTERISTICS

SCANING ELECTRON MICROSCOPE SEM



worn surface morphology

CONFOCAL MICROSCOPE CM

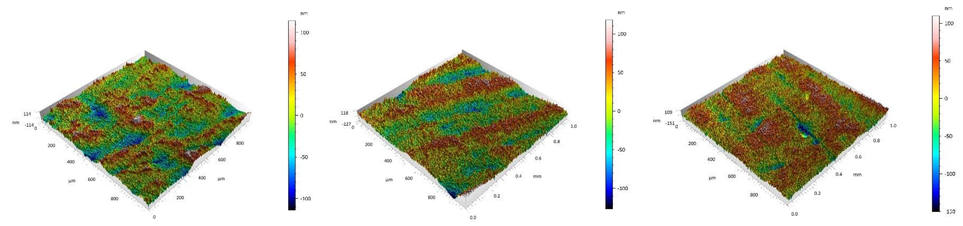


worn surface topography

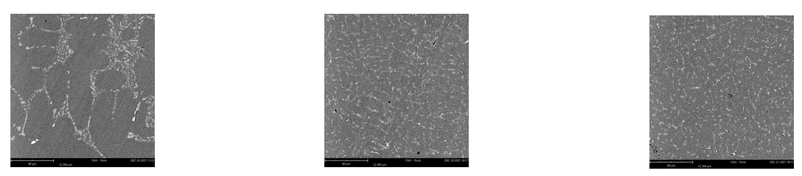
Results

MACHINED SURFACE CHARACTERISTIC

SURFACE TOPOGRAPHY

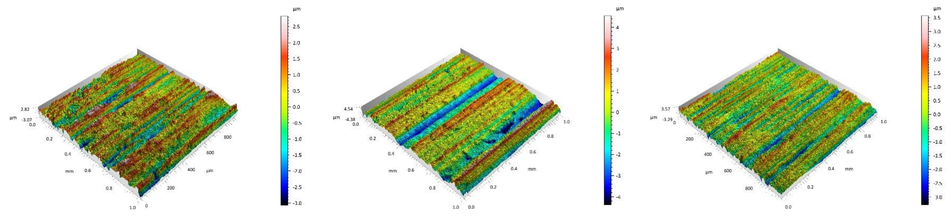


SURFACE MORPHOLOGY

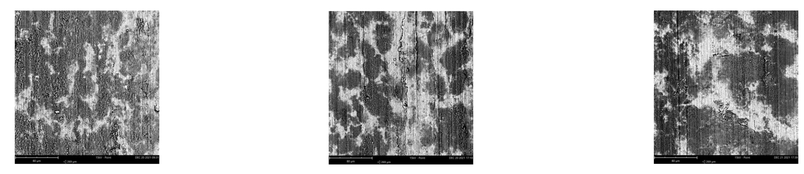


WORN SURFACE CHARACTERISTIC

SURFACE TOPOGRAPHY

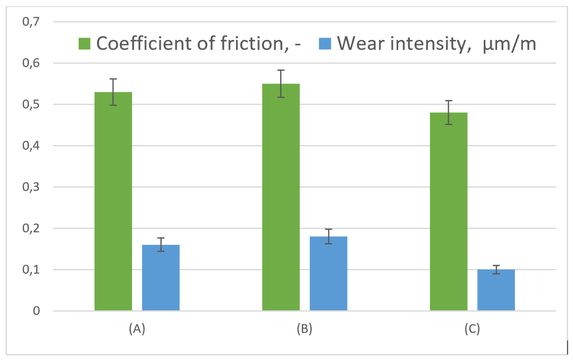


SURFACE MORPHOLOGY

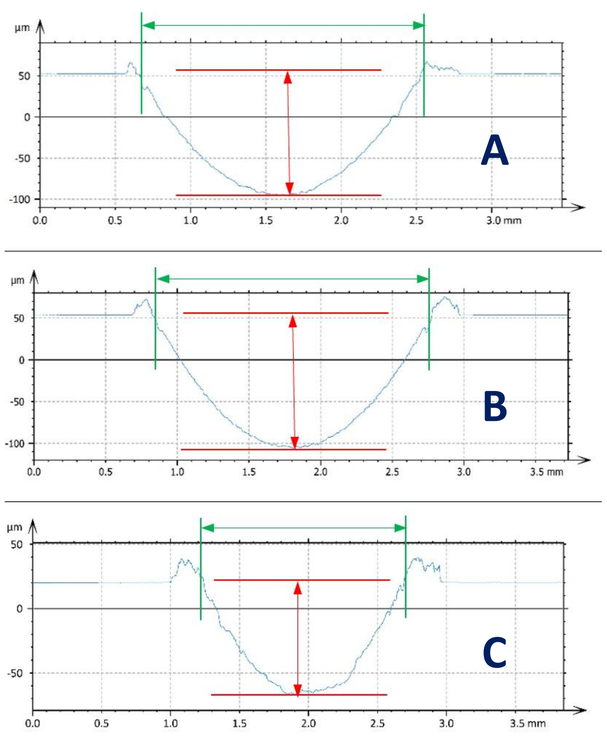


MACHINED SURFACE PARAMETERS

	Sq [µm]	Sp [µm]	Sv [µm]	Ssk [-]	Sku [-]
Ball	0.249	1.000	0.958	0.121	3.65
Plate (A)	0.035	0.114	0.114	0.168	3.23
Plate (B)	0.037	0.109	0.127	-0.024	2.90
Plate (C)	0.038	0.118	0.151	-0.580	4.34



WEAR TRACES



WORN SURFACE PARAMETERS

	Sq [µm]	Sp [µm]	Sv [µm]	Ssk [-]	Sku [-]
Ball (A)	0.739	2.97	2.31	1.20	6.08
Plate (A)	0.995	2.82	3.07	-0.378	3.05
Ball (B)	0.853	3.31	2.33	1.20	5.87
Plate (B)	1.440	4.54	4.38	-0.311	3.15
Ball (C)	0.758	3.50	1.52	2.01	8.15
Plate (C)	0.850	3.57	3.29	-0.503	3.30

Conclusions

It was shown that:

- increasing the Zr increases the surface roughness (machined surface topography and surface morphology) which is biggest for C;
- increasing the Zr addition reduces the tribological characteristics (coefficient of friction as well as a wear intercity), which are smallest for C alloy);
- wear traces, in terms of depth and width, are different; the wear trace for the C alloy is the smallest.

The studies should be continued to check that increasing (the percentage addition) the Zr addition will determine that maintains the decreasing trend of tribological characteristics.

The presented research was realized during the authors' scientific internship at the University of Žilina.