

Change in wear resistance of alloy when alloying aluminium alloy with germanium oxide

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Abstract. Various studies are being conducted on alloying materials for mechanical engineering with various unique elements. In particular, studies have been conducted to improve its properties by including elements such as lithium, zirconium, ytterbium, and erbium in the composition of the aluminum alloy. The article examines the change in the wear resistance ability of alloys in aluminum-silicon and aluminum-copper systems with germanium oxide based on their mechanical properties. The samples were poured into a resistance furnace. In this case, a germanium oxide compound was added to the charge of one to three percent. Wear resistance was determined using a diamond stone meter. At the same time, the samples were measured on the device with the strength of wear resistance at certain intervals. Based on the results obtained, a graph of the dependence of the wear resistance of the samples on the GeO mass was developed. The conclusions of the authors based on the results obtained are given in the final part of the article. The study was tested in the laboratory of the Department of Foundry Technologies of Tashkent State Technical University.

1 Introduction

Today, aluminium and its alloys are widely used in producing mechanical engineering parts. In particular, UZAUTO enterprises, which produce machine-building parts in Uzbekistan, produce parts from aluminium alloys of the AK7 aluminium alloy brand. Currently, scientists worldwide are researching improving its mechanical properties by introducing various unique elements into the structure of aluminium alloys [1-5]. Studies using rare elements as less legible elements show that their addition improves the mechanical properties of aluminium alloys. Adding cerium (Se) to the AL-Cu-Mg-Ag alloy improves the thermal stability of the Ω -phase; therefore, the operating temperature of the alloy has increased [3-4]. Some recent studies have shown that Yb (ytterbium) is

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considered an effective element with a low level of leaching in aluminium alloys [6]. It was confirmed that the addition of Yb (iterbi) improved the mechanical properties of Al-Cu-Mg-Ag and Al-Zn-Mg-Cu-Zr alloys [7-10]. In addition, the complex addition of Yb, Cr, and Zr (zirconium) to the Al-Zn-Mg-Cu alloy significantly increases the resistance to recrystallization [11-16]. The article presents the authors' research aimed at improving the mechanical properties of aluminium alloy by introducing germanium oxide into it. The research studied the influence of germanium oxide on alloys in aluminium-silicon and aluminium-copper systems. Based on the research, a graphical connection of germanium oxide with the absorption capacity based on mechanical properties was developed.

2 Materials and methods

The studies used a resistance furnace to cast aluminum samples (Figure 1). The technical parameters of the resistance furnace are given in Table 1.



Fig. 1. Resistance furnace.

Table 1. Parameters electric melting furnace.

Name of Parameters	Parameters
Power	1600 Vt
Crucible capacity	1-3 kg
Max temperature	1100 ° C
Weight	11 kg

In the studies, the composition of the AK7 and D16 brand alloys included germanium oxide, a combination of germanium with oxygen. Technically, germanium is classified as a metalloid or semi-metal, one of a group of elements that possess properties of both metals and non-metals. In its metallic form, germanium is silver in color, hard, and brittle. Germanium's unique characteristics include its transparency to near-infrared electromagnetic radiation (at wavelengths between 1600-1800 nanometers), its high refractive index, and its low optical dispersion [17]. Germanium dioxide, also called germanium (IV) oxide, germanium, and salt of germanium, is an inorganic compound with the chemical formula GeO_2 . It is the main commercial source of germanium. It also forms a passivation layer on pure germanium in contact with atmospheric oxygen [18].

Germanium oxide was introduced into the samples in a ratio to the charge weight of 1%, 2%, 3%. The samples were poured into sand-clay molds at a temperature of 750 ° C [19-20]. The cast samples were processed by cutting on a lathe of the same size, 17x23 mm. The cut samples were examined on a device to measure the wear resistance of a diamond stone. The drawing of the device is shown in Figure 2. In doing so, using the method of reducing the length of the samples, their eyelight was measured.



Fig. 2. Device that measures wear resistance

Each sample was kept in the device under the same forces of 50 N for 10 minutes. Samples were taken from the device, and their height was measured (Figure. 3).



Fig. 3. Post-test sample.

In subsequent studies, the microscopic structures of samples were studied. For this, the Olympus metallographic microscope was used. Microscopic structures of samples are given in Figures 4-5.

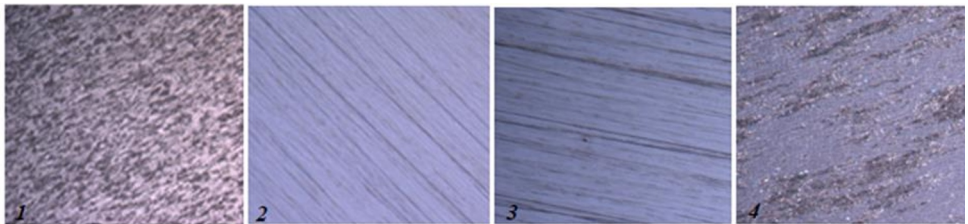


Fig. 4. Microscopic structures of samples: 1-Al-Si; 2-Al-Si+GeO 1%; 3-Al-Si+GeO 2%;4- Al-Si+GeO 3%.

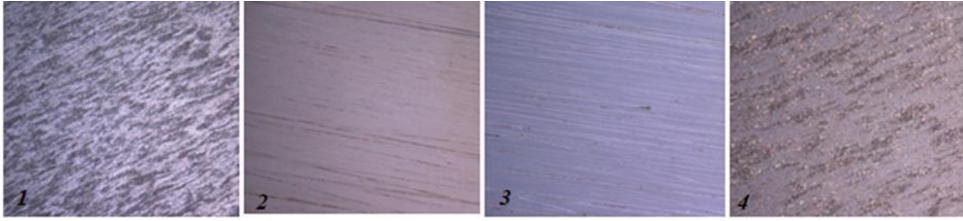


Fig. 5. Microscopic structures of samples: 1-Al-Cu; 2-Al-Cu+GeO 1%; 3-Al-Cu+GeO 2%;4- Al-Cu+GeO 3%.

3 Results and discussion

Then the first AK7 (aluminum-silicon) alloy samples were measured, while the D16 (aluminium-copper) alloy samples were measured. The results of changing the heights of the samples are presented in the table (Table 2).

Table 2. The results of measuring the wear resistance of the samples are presented.

Name of the alloy system	GeO ₂ +0%	GeO ₂ +1%	GeO ₂ +2%	GeO ₂ +3%
aluminum-silicon	19.10	20.50	21.70	20.50
aluminium-copper	20.00	21.50	22.30	19.70

Based on the measurement results, a binding graph was developed (Fig. 6). At the same time, it was taken as a basis that the height of the poured samples was reduced due to the compound with germanium oxide. The measurement results showed the effect of germanium oxide on the alignment of aluminum alloys.

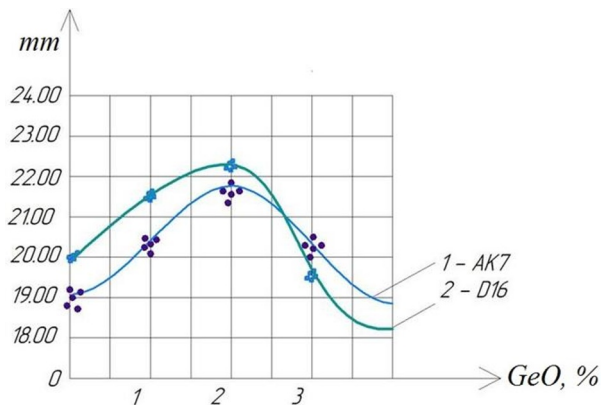


Fig. 6. Link graph

4 Conclusions

Based on the above experiments, the following conclusion can be drawn when aluminum alloy is leached with germanium oxide, the hardness of the alloy increases by 10-15%. When we introduce germanium oxide in the amount of 1% and 2% into the composition of

an aluminum alloy, it can be seen that it has increased wear resistance and 3%; on the contrary, it has decreased. Microscopic analysis shows that germanium oxide decreased the content of gases and non-metallic additives in the alloy. As a result, its wear resistance has increased. In conclusion, it should be noted that the inclusion of germanium oxide in the alloy from 1% to 2% serves to increase its mechanical properties

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