American Journal of Applied Science and Technology

VOLUME Vol.05 Issue01 2025
PAGE NO. 18-22
DOI 10.37547/ajast/Volume05Issue01-05

Change the hardness of the alloy based on changing the composition of aluminum alloys

Tursunbaev Sarvar
Tashkent State Technical University named after Islam Karimov, 100095, University 2, Tashkent, Uzbekistan

Dovulov Shukhrat
Tashkent State Technical University named after Islam Karimov, 100095, University 2, Tashkent, Uzbekistan

Tadjiyev Nuritdin
Tashkent State Technical University named after Islam Karimov, 100095, University 2, Tashkent, Uzbekistan

Murodov Sobirjon
Tashkent State Technical University named after Islam Karimov, 100095, University 2, Tashkent, Uzbekistan

Turakhujaeva Azizakhon
Tashkent State Technical University named after Islam Karimov, 100095, University 2, Tashkent, Uzbekistan

Rakhmonova Mokhinur
Tashkent State Technical University named after Islam Karimov, 100095, University 2, Tashkent, Uzbekistan

Received: 20 October 2024; **Accepted:** 22 December 2024; **Published:** 12 January 2025

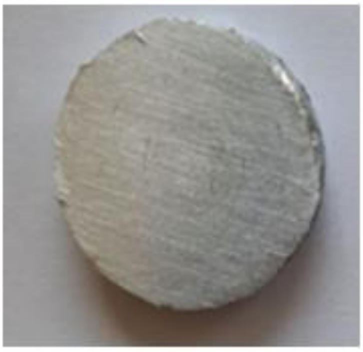
Abstract: This article analyzes the influence of germanium on aluminum alloys. The article examines how germanium oxide is introduced into its composition during melting of aluminum-manganese, aluminum-copper, aluminum-magnesium alloys and its hardness changes. Based on the results of the conducted research, the conclusions and suggestions of the authors are presented at the end of the article.

Keywords: Hardness, alloying, aluminum, manganese, copper, magnesium, germanium, furnace.

Introduction: Aluminum alloys have better mechanical and technological properties than pure aluminum. Therefore, aluminum alloys are widely used in mechanical engineering, aircraft manufacturing, shipbuilding, construction and agriculture. Aluminum stands out among structural materials due to its important properties (relative strength, electrical and thermal conductivity, corrosion resistance). Aluminum forms solid solutions with different compositions that look like alloying elements. Due to the growing demand for aluminum alloys in industry, scientists around the world are conducting research to improve their properties. In particular, research aimed at improving the properties of aluminum alloys by introducing various alloying elements into them was carried out by the Iranian scientist S.G. Shabestari and others studied the influence of copper and the state of solidification on the microstructure and mechanical properties of Al-Si-Mg alloys. The researchers used aluminum alloy grade A356 with a copper content of 0.2–2.5%, cast under various solidification conditions (in sand, graphite, copper, and cast iron molds). The highest tensile strength was obtained with heat treatment of alloys (T6), mold cooling rate (graphite) and copper content up to 1.5%. The best mechanical properties were demonstrated by dissolving approximately 1.5% Cu in the Al-Si-Mg alloy in graphite molds. In this article, the authors studied the effect of introducing germanium oxide into aluminum and its mechanical properties, including hardness.

METHODS

The studies were conducted on aluminum alloys in the aluminum-copper, aluminum-magnesium and aluminum-manganese systems. These alloys contain germanium oxide. As a result of the introduction of this compound, the oxygen contained in it was released, and the germanium was absorbed by the alloy. Germanium is located in period 4 th group,14 of the periodic table of chemical elements, with atomic number 32. Denoted as Ge (Germany), Germanium is a grey-white intermediate optical material that is shiny like metals. Like silicon, it is a semiconductor. Germanium is usually extracted from nickel and tungsten ores as a semi-metallic compound. It is also obtained from the composition of silicates. After very complex processing of the ore, germanium oxide is released in the form of GeO2. In the experiments, aluminum alloys were melted in a resistance furnace with the addition of germanium oxide. First, for comparison, samples were cast in aluminum alloys without the addition of germanium oxide. At the next stage, the element germanium was added to the alloys of the selected grade in the form of oxide in an amount of 0.1% to 0.3% relative to the batch.



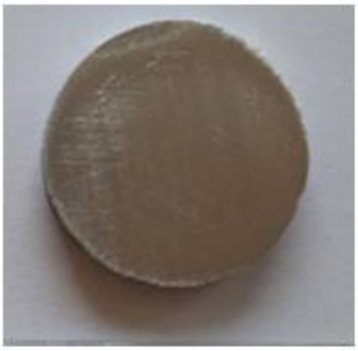


Fig.1. Processed samples.

From each selected alloy grade, samples with three different compositions were cast. The cast samples were cut on a lathe to the required size and shape. The cut and processed samples are shown in figure1. The following tables present the chemical composition of the samples.

Table 1.

Alloy in the aluminum-manganese system

№	Brand	Percentage of elements by mass, %										
		Al	Si	Fe	Cu	Mn	Mg	Ti	Be	Zn	Ge	Cr
1	АМц	96,3-99	0,6	0,7	0,05-0,2	1-1,5	-	-	-	0,1	-	-
2	АМц	96,3-99	0,6	0,7	0,05-0,2	1-1,5	-	-	-	0,1	1	-
3	АМц	96,3-99	0,6	0,7	0,05-0,2	1-1,5	-	-	-	0,1	2	-
4	АМц	96,3-99	0,6	0,7	0,05-0,2	1-1,5	-	-	-	0,1	3	-

Table 2.

Alloy in the aluminum-copper system

№	Brand	Percentage of elements by mass, %										
		Al	Si	Fe	Cu	Mn	Mg	Ti	Be	Zn	Ge	Cr
1	Д16	91-94,7	0,5	0,5	3,8-4,9	0,3-0,9	1,2-1,8	0,1	-	0,3	-	0,5
2	Д16	91-94,7	0,5	0,5	3,8-4,9	0,3-0,9	1,2-1,8	0,1	-	0,3	1	0,5
3	Д16	91-94,7	0,5	0,5	3,8-4,9	0,3-0,9	1,2-1,8	0,1	-	0,3	2	0,5
4	Д16	91-94,7	0,5	0,5	3,8-4,9	0,3-0,9	1,2-1,8	0,1	-	0,3	3	0,5

Table 3.

Alloy in the aluminum-magnesium system

№	Brand	Percentage of elements by mass, %										
		Al	Si	Fe	Cu	Mn	Mg	Ti	Be	Zn	Ge	Cr
1	АМг5	91,9-94	0,5	0,5	0,1	0,3-0,8	4,8-5,8	0,1	0,005	0,2	-	-
2	АМг5	91,9-94	0,5	0,5	0,1	0,3-0,8	4,8-5,8	0,1	0,005	0,2	1	-
3	АМг5	91,9-94	0,5	0,5	0,1	0,3-0,8	4,8-5,8	0,1	0,005	0,2	2	-
4	АМг5	91,9-94	0,5	0,5	0,1	0,3-0,8	4,8-5,8	0,1	0,005	0,2	3	-

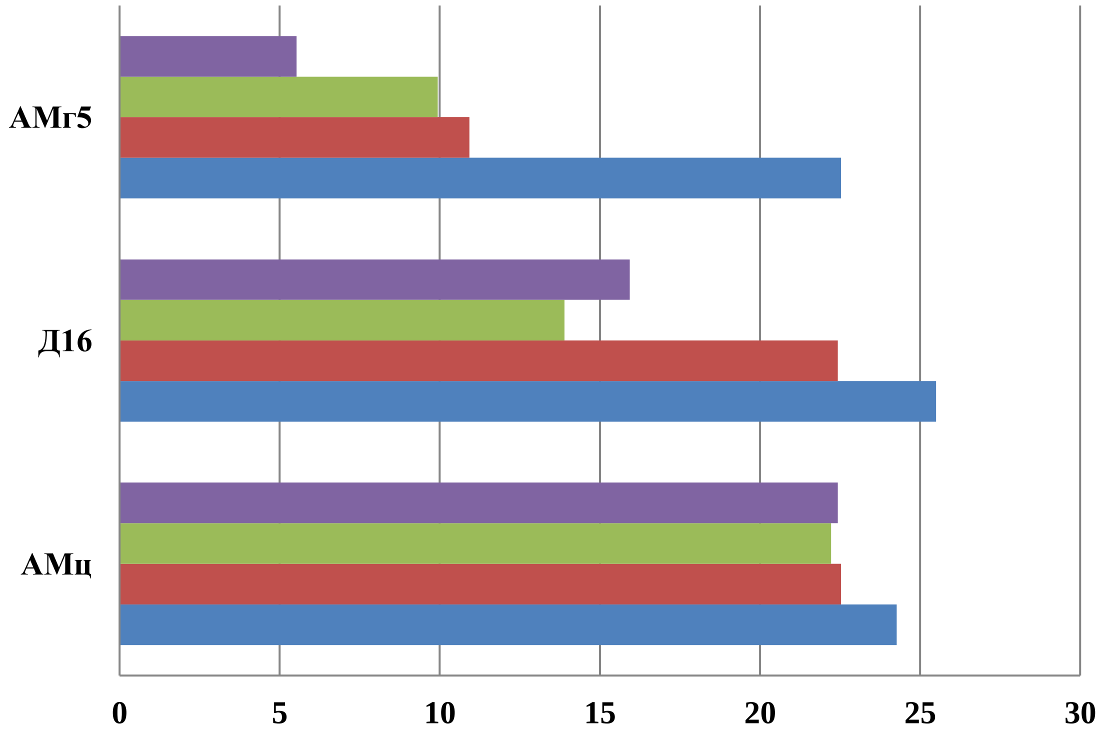
RESULTS AND DISCUSSIONS

The cut and processed samples were ground and their hardness was measured. Hardness was measured on the Brinell scale. To measure hardness, a hardness tester "Rockwell type hardness tester FR" was used. (Fig. 2).

Fig. 2. Rockwell type hardness tester FR.

The hardness of the samples was measured at three different points on the same surface. The results of the hardness measurements are presented in the diagrams below.

Results of hardness measurments



	АМц	Д16	АМг5
3 % Ge	22.43	15.93	5.53
2% Ge	22.22	13.9	9.94
1 % Ge	22.53	22.43	10.93
0 % Ge	24.27	25.5	22.53

CONCLUSION

Based on the experience gained, the following conclusions can be drawn. Overall, germanium oxide did not have a positive effect on the hardness of aluminum alloys. Germanium oxide did not have a significant effect on the hardness of the alloy in the aluminum-manganese system. However, this sharply reduced the hardness of alloys in the aluminum-copper and aluminum-magnesium systems. Therefore, it is recommended to include germanium oxide in the alloy composition together with other elements. For example, studies have shown that its inclusion in combination with strontium and silicon increases the hardness of the alloy.

REFERENCES

Sarvar, T., Nodir, T., Mardonov, U., Saydumarov, B., Kulmuradov, D., & Boltaeva, M. (2024). EFFECTS OF GERMANIUM (GE) ON HARDNESS AND MICROSTRUCTURE OF AL-MG, AL-CU, AL-MN SYSTEM ALLOYS. International Journal of Mechatronics and Applied Mechanics, (16), 179-184.

Sarvar, T., Nodir, T., Shohista, S., Anvar, T., & Mashhura, M. (2024). DEVELOPMENT OF A MATHEMATICAL MODEL OF THE EFFECT OF LITHIUM ON THE WEAR RESISTANCE PROPERTIES OF ALUMINUM-LITHIUM ALLOYS. American Journal Of Applied Science And Technology, 4(01), 37-41.

Tan, C. F., & Radzai, S. M. (2009). Effect of hardness test on precipitation hardening aluminium alloy 6061-T6. Chiang Mai Journal of Science, 36(3), 276-286.

Asgharzadeh, A., Nazari Tiji, S. A., Esmaeilpour, R., Park, T., & Pourboghrat, F. (2020). Determination of hardness-strength and-flow behavior relationships in bulged aluminum alloys and verification by FE analysis on Rockwell hardness test. The International Journal of

Advanced Manufacturing Technology, 106, 315-331.

Tursunbaev, S., Turakhodjaev, N., Odilov, F., Mardanokulov, S., & Zokirov, R. (2023). Change in wear resistance of alloy when alloying aluminium alloy with germanium oxide. In E3S Web of Conferences (Vol. 401, p. 05001). EDP Sciences.

Sarvar, T., Nodir, T., & Sharofuddin, M. (2022). Changes in the Hardness of Aluminum Alloys in the Influence of Lithium. Eurasian Journal of Engineering and Technology, 8, 56-60.

Kim, K. C., Park, S. H., Na, M. Y., Chang, H. J., Kim, W. T., Mattern, N., ... & Kim, D. H. (2015). Formation of nano-porous GeOx by de-alloying of an Al–Ge–Mn amorphous alloy. Scripta Materialia, 104, 49-52.

Tursunbaev, S., Turakhodjaev, N., Saidxodjayeva, S., & Hudoykulov, S. (2023). INFLUENCE OF ALLOYING ELEMENTS ON ALUMINUM ALLOYS. International Journal of Advance Scientific Research, 3(09), 46-50.

Davis, R. M., & Koch, C. C. (1987). Mechanical alloying of brittle components: silicon and germanium. Scripta metallurgica, 21(3), 305-310.

Tursunbaev, S., Turakhodjaev, N., Mardonakulov, S., & Hudoykulov, S. (2023). EFFECT OF GERMANIUM OXIDE ON ALUMINUM ALLOY STRUCTURE. American Journal of Applied Science and Technology, 3(09), 10-13.

Tursunbaev, S., Umarova, D., Kuchkorova, M., & Baydullaev, A. (2022, June). Study of machining accuracy in ultrasonic elliptical vibration cutting of alloyed iron alloy carbon with a germanium. In Journal of Physics: Conference Series (Vol. 2176, No. 1, p. 012053). IOP Publishing.

Hill, R., Storåkers, B., & Zdunek, A. B. (1989). A theoretical study of the Brinell hardness test. Proceedings of the Royal Society of London. A. Mathematical and Physical Sciences, 423(1865), 301-330.

Ponnusamy, P., Rahman Rashid, R. A., Masood, S. H., Ruan, D., & Palanisamy, S. (2020). Mechanical properties of SLM-printed aluminium alloys: a review. Materials, 13(19), 4301.

Tursunbaev, S., Turakhodjayev, N., Mardanokulov, S., & Tashbulatov, S. (2023). Influence of germanium oxide on the mechanical properties of aluminum alloy. Eurasian Journal of Engineering and Technology, 16, 91-94.

Sarvar, T. (2022). Changes in its Wear Resistance When Alloying Aluminum Alloys with Lithium. Texas Journal of Engineering and Technology, 12, 32-36.

Sarvar, T., Nodir, T., Shoxista, S., Ruslan, Z., & Sharofuddin, M. (2022). The effect of lithium fluoride compound on slag decomposition in the process of casting aluminum prepared details. Asian Journal Of Multidimensional Research, 11(7), 46-50.

Tashbulatov, S., Tursunbaev, S., Omonov, F., Zokirov, R., & Shaxzod, S. (2024, October). ANALYSIS OF SLAG FORMATION AND THEIR CHARACTERISTICS DURING MELTING OF FERROUS METAL ALLOYS. In Uz Conferences (Vol. 1, No. 1).

Xu, R., Zhao, H., Li, J., Liu, R., & Wang, W. K. (2006). Microstructures of the eutectic and hypereutectic Al–Ge alloys solidified under different pressures. Materials Letters, 60(6), 783-785.