EFFECT OF SILICON, TITANIUM AND GRAPHENE ON FLUIDITY OF AL-MG ALLOYS

Azizakhon Turakhujaeva[1], PhD student, Sarvar Tursunbaev[1], associate professor PhD, Fakhriddin Mahmudov[1], PhD student
Tashkent State Technical University[1], Uzbekistan

Fluidity is one of the main characteristics of aluminum alloys, which indicates the durability and economic and environmental efficiency of the alloy. In particular, considering the significant differences between aluminum-magnesium alloys with 5-6% magnesium and alloys with 10% magnesium in many characteristics of the alloy, studies on the effect of adding silicon can play a huge role in improving the quality of the material and thus its fluidity.

For the experiments, molds were first made consisting of 11% bentonite, 85% quartz sand, and the remaining 4% water. Then, they were mixed using a runner for 10-15 minutes, while the aluminum-magnesium alloy was melted in an induction furnace at a temperature of 750° C.

Table 1. The number of alloying elements added to the aluminum-magnesium alloy for subsequent analyses.

Base alloy/Alloying elements	Silicon (%)	Titanium (%)	Graphene (%)
Al-Mg alloy	1	0	0
Al-Mg alloy	2	0	0
Al-Mg alloy	3	0	0
Al-Mg alloy	0	0.2	0
Al-Mg alloy	0	0.3	0
Al-Mg alloy	0	0.4	0
Al-Mg alloy	0	0	0.15
Al-Mg alloy	0	0	0.3
Al-Mg alloy	0	0	0.45

The base alloy is aluminum-magnesium and in total it was prepared 10 alloys with additional elemernts, the contents of the additional elements are given in the table above (table 1) and the comparative diagram was drawn based on the alloys: aluminum-magnesium (base alloy), base alloy with silicon (1%, 2%, 3%), base alloy with titanium and the base alloy with graphene.

However, when melting aluminum-magnesium alloys with graphene and graphene oxide additives, careful handling and attention were required during melting: some parts of graphene and graphene oxide were released into the environment, and after adding graphene they were poorly mixed, and special conditions were required for their melting.

After preparing the molten alloys and preparing the sand mold, the melted alloys were then poured into the mold, and the results were recorded as follows, as shown in figure 1.

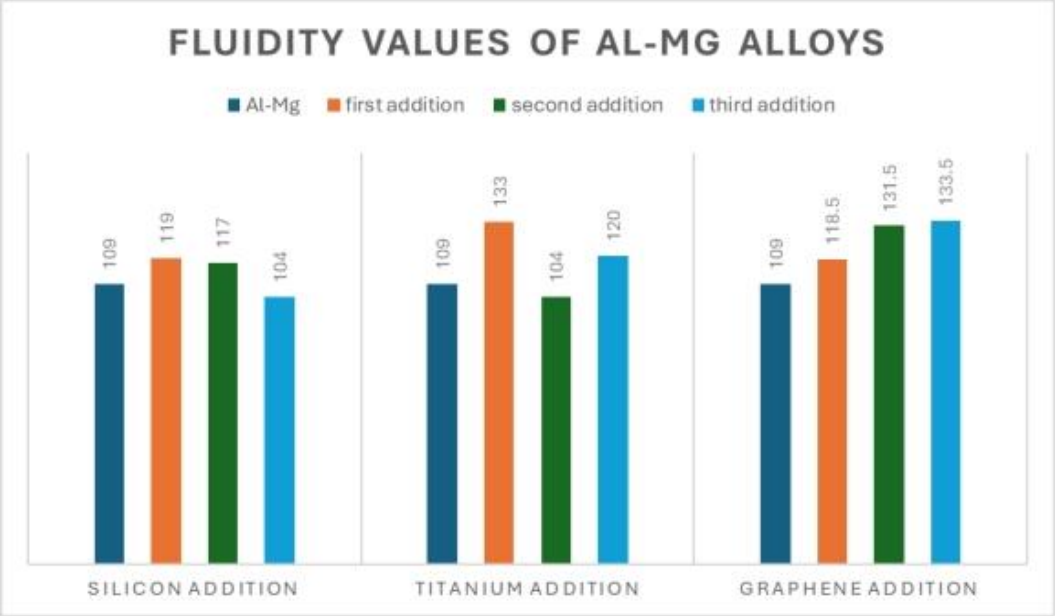


Figure 1. Comparative diagram of the fluidity length (cm) of the alloys.

Figure 1 shows the comparative diagram of al-mg alloys with 10 different contents. It is clear that the best effect in the fluidity was recorded with graphene addition showing a constant increase in the length (from 109cm to 133.5cm). Although, some additions of titanium (0.3%) and silicon (3%) lead to a decrease in the fluidity ability of Al-Mg alloy, overall effect of each element was significant. Silicon is well-known element for its ability to substantially increase the fluidity of alloys, especially aluminium alloys. The best effect of silicon was noticed when adding 1%, while titanium had a better result when the addition of the element is equal to 0.2%.

It can be concluded that graphene gives promising results in terms of fluidity effect on aluminium alloys (0.45%) and the second dominant element for a better fluidity effect was found to be 0.2% titanium, the fluidity length of which is 133cm (0.2% of titanium). Graphene effect had a great effect on fluidity not only with the addition of 0.45% of graphene, but also with 0.15% and 0.3% of graphene additions, changing the length from 109cm to 118.5cm and 133cm, respectively.

Literature:

1. Bhardwaj, A. R., & Purohit, R. (2026). Aluminum alloys in sustainable manufacturing: A review. *Sustainable Materials and Technologies*, e02028.

2. Rong, Z., Rong, X., Zhao, D., Xu, Z., Zhang, X., Sha, J., ... & Zhao, N. (2026). Recent advances in hierarchical heterostructures and mechanical properties of additively manufactured aluminum alloys. Microstructures, 6(1), N-A.

3. Lin, Z., & Yang, C. (2026). Artificial Intelligence Design of Sustainable Aluminum Alloys: A Review. Computers, Materials & Continua, 86(2).