Optimization of metallic glasses for additive technologies. The role of entropy and enthalpy in formation of amorphous structure

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Abstract:

Until now, many different methods of amorphous alloys design were proposed. Generally, they are associated with the trial and error approach. In this group of methods, the influence of different chemical elements on the glass forming ability can be determined empirically based on the results of the analysis of many different alloying systems. However, this approach is time-consuming and cannot be implemented in the industry.

Recently, due to the development of additive technologies, new alloying systems with high glass forming ability are sought. The usage of common alloys systems is significantly limited. Therefore, a new approach to determining the optimal chemical composition, which also can be used to describe the crystallization (especially nanocrystallization) process is required. According to that, the thermodynamic approach for alloy design was introduced and described in this work. The analysis of different parameters, such as configurational entropy, mismatch entropy, mixing enthalpy and enthalpy formation of intermetallic phases can be successfully used to determine the optimal chemical composition of alloys with high glass forming ability. Moreover, the proposed approach can be used to understand the crystallization process from the melt, amorphous phase, nanocrystallization process and influence of chemical elements on the glass forming ability in many alloying systems. In this work results of the analysis performed for different Fe-based alloys are presented. Determined influence of chemical elements, such as: copper, cobalt, silicon on the glass forming ability on the basis of the analysis of thermodynamic parameters is related to the changes in the entropy and enthalpy.

Key words:

Amorphous alloys, enthalpy, entropy, glass forming ability