Nanocomposites and nanomaterials

Structure of the alloy $Mg_{65}Cu_{25}Y_{10}$ obtained by casting the melt into a heated mold

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As is known, quenching from a melt allows obtaining perspective materials with a unique combination of properties. The peculiarity of the properties of such materials is in most cases due to the presence of amorphous or nanocrystalline structural constituents. Character structure thus depends on the thermal regime of the quenching process. Moreover, if the production of an amorphous component can be achieved under cooling conditions with rates close to critical, the production of nanocrystalline structures by continuous cooling of the melt is problematic. One way to overcome this drawback of methods of quenching from a melt is to obtain crystalline ingots by casting a melt into a preheated mold [1].

Taking into account the above, in the present work, using mathematical modeling methods, the possibility of obtaining nanocrystalline structures in a bulk amorphisable alloy $Mg_{65}Cu_{25}Y_{10}$ at cast into a heated mold, was studied. In this case, by an agreed numerical solution of the thermal and kinetic problems, the influence of the thermal conditions of melt solidification on the final microstructure parameters of the casting with a thickness of 4 mm was studied. As the variable parameter of the model using the initial temperature of the mold T_b, which was selected in such a way that the solidification of the casting proceeds in isothermal conditions near the glass transition temperature T_g. It is shown that the possibility of establishing this isothermal regime is observed in the interval T_b from 414 K to 424 K, the crystallization of the melt is carried out in the temperature range from 414 K to 462 K. Such a thermal regime provides a high rate of nucleation of solid phase crystals $I_{iso}=8\cdot10^{13}–2\cdot10^{17}$ $m^{-3}\cdot s^{-1}$ and very low crystal growth rates $u_{iso}=8\cdot10^{-15}–5\cdot10^{-11}$ $m\cdot s^{-1}$. The observed combination of kinetic parameters I_{iso} and u_{iso}, contributes to obtaining a completely crystalline castings primary nanocrystalline structure with an average crystal size $\overline{R}$ =56–95 nm. In this case, the duration of solidification, depending on the values T_b, and vary from $2{,}2\cdot10^7$ s to $2{,}5\cdot10^3$ s. Based on these data, it was concluded that the optimal values T_b, in which it is possible to produce castings with nanocrystalline structure for reasonable in practical terms intervals (2 – 0,7 hours), are values 421 – 424 K.

1. O.B. Lysenko, O.L. Kosynska, O.O. Lysenko, T.V. Kalinina Effect of Isothermal Quenching from the Liquid State on the Microstructure of $Cu_{47}Ni_8Ti_{34}Zr_{11}$ // MFiNT. – 2015. – **37**, N 5. – P. 689–709.