Нанокомпозити та наноматеріали

Formation of nanocrystalline structures in $Mg_{65}Cu_{25}Y_{10}$ alloy by casting in metal mold

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By means of a method of mathematical modeling an influence of a thermal cooling regime on crystallization kinetics and a final microstructure of $Mg_{65}Cu_{25}Y_{10}$ alloy received by melt-cast into a solid metal mold, is investigated. It is established, that, depending on a thickness of casting $2l_1$, crystallisation occurs in various thermal conditions that is reflected in kinetic parametres of process and final structure of alloy.

So in castings with a half-thickness $l_1 \leq 3{,}2$ mm the crystallisation thermal effect is low in comparison with a heat flow removed in the mold wall. In this case, the crystallization process has no significant effect on the course of temperature decrease, and it smoothly decreases to a glass transition temperature T_g. Such mode causes a consistent suppression of growth and nucleation of crystalline phase and occurs the amorphous state formation.

At increasing melt half-thickness $l_1 \geq 8{,}665$ mm, in the temperature curve a sharp increase of temperature up to the melting temperature T_m, is observed, which indicates the release of the latent crystallization heat. At such mode the completely crystalline structure with crystal size between 0.1 and 100 microns, is fixed.

In the half-thickness interval of 3,2 mm$< l_1 <$8,664 mm crystallization occurs during deep undercoolings in conditions close to isothermal. Such a change in the thermal regime leads to an increase in the nucleation process contribution in crystallized volume fraction, as evidenced by the high values of the number of crystals per unit volume N_S, which vary from $3{,}6 \cdot 10^{16}$ m^{-3} to $4{,}7 \cdot 10^{19}$ m^{-3} and lower values of the crystal growth rate $u \sim 10^{-11}$ ms^{-1}. Under such conditions, the castings does not have time to fully crystallize and become amorphous-crystalline structure with an average crystal size from 14,7 nm to 132 nm. The obtained data suggest that in principle the possibility of obtaining the alloy primary nanocrystalline structures by controlling the thermal conditions by changing the casting thickness.