Physico-chemical nanomaterials science

Kinetics study of nanocrystallization in $Fe_{82}Nb_2B_{14}RE_2$ (RE = Y, Gd, Tb, Dy) amorphous alloys

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The crystallization kinetics of the amorphous alloys have been studied by differential scanning calorimetric (DSC). The investigated objects were $Fe_{82}Nb_2B_{14}RE_2$ (RE = Y, Gd, Tb, Dy) amorphous alloys produced by melt spinning method. The first peak on the DSC conditionally characterized by the three temperatures: T_1-onset growth, T_2-growth and T_3-completing the growth of nanocrystals. The activation energies of nanocrystallization were calculated according to Kissinger (E_{a1}), Ozawa(E_{a2}) and Augis-Bennett (E_{a3}) kinetic models [1] for the all temperatures (Table 1). By using Augis-Bennett model has been calculated the frequency factor for this temperatures.

Table 1. Calculated activation energy (E_{a1}, E_{a2}, E_{a3}), frequency factor (K_0) at temperatures early growth (T_1) and growth (T_2) nanocrystals for different models

Alloys	E_{a1}, kJ/mol		E_{a2}, kJ/mol		E_{a3}, kJ/mol		K_0, s^{-1}	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
$Fe_{84}Nb_2B_{14}$	234	232	246	245	240	238	$6.42\cdot10^{16}$	$1.06\cdot10^{16}$
$Fe_{82}Nb_2B_{14}Y_2$	599	567	612	580	605	574	$6.67\cdot10^{37}$	$2.18\cdot10^{35}$
$Fe_{82}Nb_2B_{14}Gd_2$	585	581	598	595	591	588	$1.76\cdot10^{37}$	$3.56\cdot10^{36}$
$Fe_{82}Nb_2B_{14}Tb_2$	598	561	612	575	605	568	$9.79\cdot10^{37}$	$1.26\cdot10^{35}$
$Fe_{82}Nb_2B_{14}Dy_2$	558	543	572	557	565	550	$2.42\cdot10^{35}$	$9.14\cdot10^{33}$

Replacement of 2 at. % of Iron on RE in the base alloy $Fe_{84}Nb_2B_{14}$ leads to increased activation energy of 2-2.5 times. The activation energy has high values and indicating the complicated processes of diffusion in the amorphous matrix. K_0 is proportional to the number of crystallization centers in the amorphous matrix. As can be seen from Table 1, the number of crystallization centers increases alloys matrix are doped with RE metals.

1. *Musiał A., Śniadecki Z., Idzikowski B.* Thermal stability and glass forming ability of amorphous $Hf_2Co_{11}B$ alloy // Materials and Design.-2017.-**114**, N 15. P. 404–409.