"Nanocomposites and nanomaterials"

Properties of novel amorphous-crystalline Al-based alloy doped by Ga

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In our previously published study [1] it was shown that amorphous-crystalline $Al_{75}Ni_{20}Y_4Gd_1$ alloy with increased Ni content has high microhardness (13.2 GPa) after appropriate heat treatment. Increasing of glass-forming ability of alloy could improve its manufacturability and perhaps microhardness. The influence of Ga addition (2 at.%) on the properties of the alloy had been investigated in this paper.

It was revealed by X-ray diffraction analysis that the initial state of as-cast $Al_{75}Ni_{18}Ga_2Y_4Gd_1$ ribbon (obtained by melt-spinning technique) is amorphous-crystalline. Results of differential scanning calorimetry indicated that crystallization behavior of this alloy is close to eutectic. Doping of the alloy by Ga decreases its thermal stability (T_{ons}) from 400 to 360 °C compared to the base $Al_{75}Ni_{20}Y_4Gd_1$ alloy. Also exothermic effect during crystallization of the ribbon at continuous heating increases from 100 to 150 J/g which indicates a significantly greater volume fraction of amorphous phase in the initial state. Heat treatment of $Al_{75}Ni_{18}Ga_2Y_4Gd_1$ ribbon at 360 °C for 5 min leads to crystallization of Al and solid solution of Ga in the intermetallic compounds (IMC) Al_3Ni, Al_3Ni_2, Al_4NiR, $Al_{23}Ni_6R_4$ (where R = Y, Gd), in contrast to the alloy $Al_{75}Ni_{20}Y_4Gd_1$, which crystallizes with aluminium and IMC Al_3Ni, Al_9Ni_3R and $Al_{19}Ni_5R_3$. Microhardness of the alloy doped by gallium changes from 6.0 ± 0.4 GPa (in the initial state) to 9.5 ± 0.7 GPa (after specified heat treatment).

1. Mika T., Nazarenko A., Zelinska G., Kotur B., Nosenko V. Influence of alloying and heat treatment on microhardness of nanocrystalline Al-Ni-Co-Y-Gd alloys // Thesis of International Conference «NANSYS 2013» (24 – 28 October, 2013). – Kyiv, 2013. – p. K12.