Nanocomposites and nanomaterials

The impact of gas environment on crystallization process of amorphous Zr-based alloys during obtaining nanoscale materials from them

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The nanostructured metal materials have unique physical and mechanical properties. The materials can be obtained by heat treatment of amorphous alloys. Thermal stability of amorphous alloys is determined by their crystallization temperature (Tx), but the crystallization processes start much lower, particularly they are distinguishable above the glass transition temperature (Tg). Therefore, the heat treatment of amorphous alloys generally are operated in the temperature range Tg - Tx to form a numerous quantity of nucleation sites, and the rate of their growth use to be relatively low. In such systems, generally nanoscale particles of metastable intermediate phases (usually intermetallics) are allocated on the first stage of crystallization. Obtaining of nanostructured materials by this method makes it possible to produce materials with outstanding mechanical properties. Improving physical and mechanical properties of the alloy occurs by reinforcement of amorphous matrix by high-modulus nanoscale intermetallic compounds. Ratio of amorphous alloy's crystalline component increases with temperature and treatment time and consequently, the hardness of the materials is improved. The strength increases to a certain top level, further increasement of temperature and treatment time has opposite effect.

Our studies show the structure of crystallized amorphous samples depends also on gas environment of thermal treatment, especially for amorphous tape-like samples. Crystallization of amorphous alloy in the air starts at a lower temperature and occurs by a different mechanism than in argon atmosphere. Crystallization in nitrogen environment also differs from crystallization in argon, but less than in air. Bulk amorphous alloys bigger than 1 mm crystallize in argon the same as in air. For this reason, the affect of nanostructured hardening by heat treatment is relying from its gaseous environment.

Environment	Tx, °C	ΔH, J/g
Air	408,1	1074
Nitrogen	441,7	233,2

Argon	440,1	41,73