LOW-TEMPERATURE ACOUSTIC PROPERTIES OF NANOSTUCTURED Cu AND Cu-BASED NANOCOMPOSITES OBTAINED BY DIFFERENT METHODS OF SEVERE PLASTIC DEFORMATION

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Study of physical-mechanical properties of nanostructured (NS) metals represents significant interest considering its importance both for the industrial applications and also from the point of view of fundamental physics. Transition of materials into NS-state changes the major physical characteristics, in particular, their elastic and inelastic properties, parameters of strength and plasticity. The NS-metals have high technological and operational characteristics and therefore are perspective for use as constructional materials working in extreme operational conditions.

Among various techniques of metals structure fragmentation, the methods using severe plastic deformation (SPD) are most accessible. These are equal channel angular pressing (ECAP), high pressure torsion (HPT), repeated drawing and extrusion, etc. They allow receiving practically pore-free bulk samples. However the materials received via SPD treatment have thermodynamically non-equilibrium structure because they contain a significant amount of deformation defects, first of all, dislocations and grain boundaries. Different methods of SPD structure fragmentation (ECAP, HPT, drawing and extrusion) may not only lead to creation of huge dislocation density or large number of grain boundaries but also to formation of different types of texture. It is the origin of instability of physical-mechanical properties of nanostructured metals, both at formation of the NS-state and during subsequent thermal and mechanical treatments.

Studying of elastic and inelastic properties may be regarded as a source of the valuable information on structural changes in nanostructured metals at different stages of their preparation and post-SPD processing. First, there the quantitative information on the elastic moduli may be received. Second, these experiments allow obtaining the data on dynamic properties of crystal imperfections of different nature (dislocations, impurity atoms, grain boundaries, etc.) and their interaction with excitations in electron and phonon subsystems. Non-destructive character is an additional advantage of the acoustic measurements and allows carrying out repeated measurements on the same specimen over the wide range of external parameters (e.g. temperature). It gives a possibility to establish the temperature boundaries and kinetics of structural instability of nanostructured materials.

In the present review, the results are summarized that were obtained in the range 5 − 340 K when studying the acoustic properties of nanostructured copper and Cu-Nb and Cu-Fe fiber nanocomposites prepared with the help of different SPD methods [1-3]. A number of low-temperature acoustic anomalies are revealed caused by generation of enormous dislocation density, formation of crystallographic texture, by introducing large number of grain boundaries. It is shown that the behavior of elastic moduli and inelastic characteristics of nanostructured metals of copper appears to be essentially different depending on the SPD techniques being used. It is established that this distinction is caused by formation of different substructures during preparation of the samples investigated and by the evolution of those during subsequent post-SPD treatment.

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