

Nanoscale physics

The noise influence on the materials fragmentation modes at severe plastic deformation

D.S. Troshchenko, A.V. Khomenko, I.O. Solonar

Department of Applied Mathematics and Complex Systems Modeling, Sumy State University. Rimsky Korsakov Str., 2, Sumy-40007, Ukraine.

E-mail: d.troshchenko@mss.sumdu.edu.ua

The application of the methods of severe plastic deformation (SPD) allows to obtain the bulk metallic samples with almost pore-free submicrocrystal (SMC) or nanocrystal (NC) structure, which is rather important for modern nanotechnological process [1].

Since the physical processes occurring in the metal during the SPD are rather complex, the construction of the theoretical approaches allowing to describe qualitatively all internal changes is carried out recently. Thus, the special approach within nonequilibrium evolutionary thermodynamics is developed [2, 3]. Theory describes the evolution of defects subsystem of polycrystalline material and the formation of stationary SMC or NC structure. At the same time, the influence of additive noise on behavior of the fragmentation processes isn't investigated yet.

Thus, taking into account the influence of additive noise allowed us to present the real conditions of SPD processing and to provide the possibility of the existence of new fragmentation modes and, respectively, the formation of nanocrystalline materials with assumed properties. Using the adiabatic approach, the phase diagram is constructed. It determines the regions of realization of various types of limiting (stationary) structures depending on both the noise intensity and elastic strain. It is established that with an increase of both the values of fluctuations intensity and elastic strain the size of grains decreases in limiting structures. It is shown, that transition from basic coarse-grain structure to another fine-grained (SMC or NC) during SPD can occur according to the schemes of the first- and second-order phase transitions.

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