Chaos and ordering in dendritic pattern of a solidifying system

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Dendritic pattern is the most frequently observed pattern when the metallic system or some inorganic system are solidified. It also represents one of the most complicated patterns that evolves through the dynamical process of growth [1].

In the present report the dynamics of a motion of the solid-liquid interface having dendritic pattern is considered. To investigate the dynamics of dendritic growth, a model of local non-equilibrium solidification of a supercooled liquid is chosen. The model describes the features of solidification both at rapid interface advancing and for relatively sluggish kinetics of growth [2,3]. The morphological spectrum of a side-branch surface of a free-growing dendrite is defined using computational modeling. An evolution of dendritic pattern is considered in association with two controlling parameters: (*i*) an initial supercooling of the system, and (*ii*) a position from the tip of dendrite which is define the local undercooling at the interface. Due to the values of these parameters the interface may become unstable, periodic, and bifurcate with doubling, trebling of the period and so on. A comparison of the obtained results with the existing experimental data on solidifying systems is given.

References

[1] P.K. Galenko and V.A. Zhuravlev, *Physics of Dendrites* (World Scientific, Singapore, 1994).
[2] P. Galenko and S. Sobolev, Local nonequilibrium effect on undercooling in rapid solidification of alloys // *Physical Review E* 55 (1997) 343.
[3] P. Galenko, Extended thermodynamical analysis of a motion of the solid-liquid interface in a rapidly solidifying alloy // *Physical Review B* 65 (2002) 144103.