Spinodal decomposition of solutions during crystallization

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Motivation research: Explanation and prediction of the distribution of components in the crystallization solutions causes great difficulties. The modern theory of phase transitions cannot explain the results of many experiments of interphase mass transfer. One reason for this is the assumption that during crystallization the solution is in the metastable state. The decomposition of the solution occurs by binodal scenario in this case. Crystallization nuclei form and grow in solution. The purpose of this study to show that in many cases the solution during crystallization is in an unstable state [1,2]. The unstable condition leads to decomposition the solution by spinodal scenario. The unstable solution decomposes continuously in the whole volume in this case. The distribution component at the spinodal decomposition is determined by arbitrarily small perturbations of temperature or concentration.

Methodology & Theoretical Orientation: Experimental demonstration of spinodal decomposition of the solution is conducted video shooting process of decomposition of an aqueous solution of bromthymol blue while its crystallization. Locally - configuration thermodynamic model is used to explain the state changes of the solution during the phase transition [2,3]. This model allowed adding additional coordinate - mixing energy in the equilibrium phase diagram. Boundary of the spinodal area of the solution is built into the new coordinates. Spinodal defines curve the dynamic equilibrium that must be considered in the calculations of the processes of interphase mass transfer.

Conclusion & Significance: Spinodal decomposition of the solution explains the process of formation of a periodic distribution of the eutectic composites. The layer of the unstable solution is localized in front of the unstable interface. The unstable solution decomposes into phases, which have a composition close to the eutectic composition of the solid phases. The period of alternation of these phases is set by the period of instability of the interface [4]. Experiments show that the formation of dendrites in the mushy zone (Fig. 1) and extremum of the component concentration close to interface also occurs in the spinodal decomposition scenario. The possibility of spinodal decomposition of the

solution during its crystallization significantly alters the representation of interphase mass transfer. Many cases of the redistribution component during the phase transition cannot be explained without taking into account of spinodal decomposition.

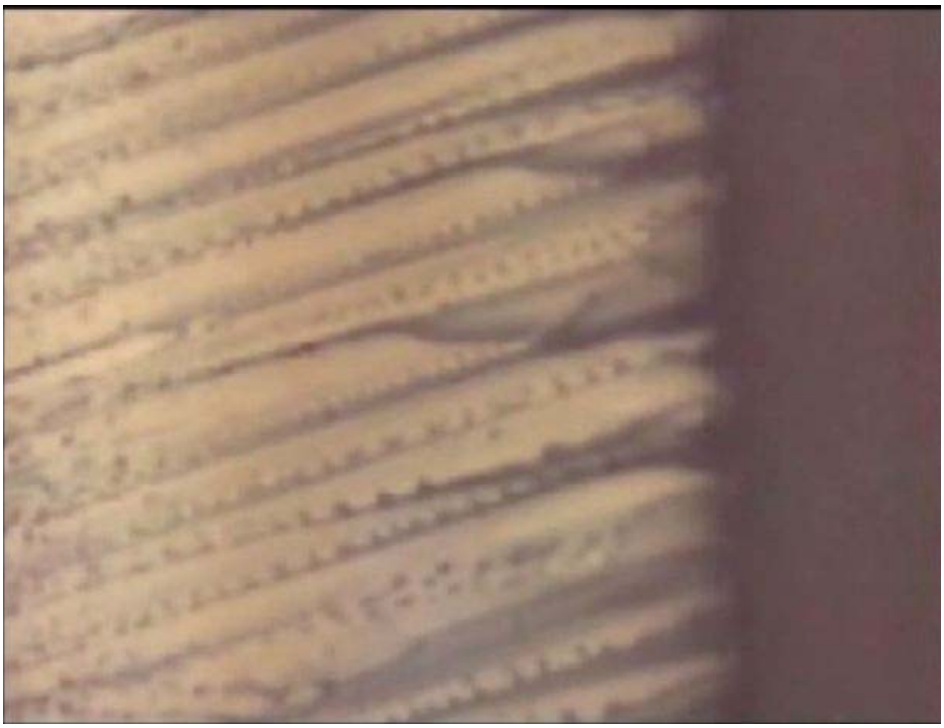

Figure 6: Formation of a dendrites branches at the borders of the eutectic structure under crystallization.

References

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