

GROWTH BEHAVIOR AND KINETICS OF SINGLE AND POLY-CRYSTALS OF SODIUM CHLORIDE

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Summary

Following the finding in 1990 that the growth rate of a single crystal of sodium chloride fixed at the tip of a platinum wire growing from a supersaturated solution is enhanced when micro-crystals are present in the solution, results of additional experiments with NaCl as well as potash alum crystals and further discussion on the mechanism are reported in detail.

Micro-crystals were generated either by the primary or secondary nucleation mechanism: and the primary nuclei were more effective than the secondary ones in the extent of enhancing the growth rates. The size of the primary nuclei was estimated in the range of 0.4 and 0.6 nm, while that of secondary nuclei is in the order of micron. This indicates that the smaller crystalline particles are more effective in enhancing the growth rate of a larger crystal. In order to make this phenomenon clear, the changes in the solution concentration during the growth were measured precisely by the use of a precision density-meter. For this purpose the potash alum-water system was adopted because of its wider metastable zone. The enhancement by the micro crystals for this system was not large in comparison with the NaCl or mCNB crystals, however since larger supersaturations were possible to apply relatively larger concentration changes were observed during the measurement of crystal growth with nucleation. By plotting the measured concentrations against the growth time of crystals, sharp discontinuities were clearly observed, i.e. a steep decrease in the concentration of the crystallizing component was observed in all the runs measured in which nucleation was intended. This fact denies a mechanism that the small ground particles introduced to cause nucleation would be dissolved in the supersaturated solution due to size-dependent solubilities. Since the solution was agitated the growth was not entirely controlled by the mass transfer step in the solution, the difference in the concentration between the bulk and the surface solutions can not be so large that the size-dependent solubility plays an important role in the enhancement.

A possible mechanism is therefore the incorporation of the micro-crystals into a growth site, the size of the microcrystals might being in a range of nanometer to submicrons, which then provides additional substantial growth sites for further growth. This type of growth enhancement may actually occur in industrial crystallizers, hence further studies in quantitative analysis are required to prove the mechanism.