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The Crystal Nucleation Phase: Evaluation of two Models

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The process of crystal nucleation is modeled by two competing, the Classical (1) and the Balanced Nucleation and Growth (2, BNG), models. Both start with the formation of agglomerates from the reactant(s). The major practical outcome is the concept of the critical nucleus. From here, the two models take different paths.

The well known classical model (1) attempts to model the nucleation rate, J (no/sec*cm^3). This nucleation rate, J, is considered constant during the nucleation phase.

On the other hand, the Balanced Nucleation and Growth (2, BNG) model focuses on the total number of stabile crystals formed, Z (no). Here, the nucleation rate (no/sec) varies during the nucleation phase and ends at a given time when only crystal growth is observed. During the nucleation phase the crystal number and size distribution is determined. The crystal number, Z, is a function of the maximum growth rate of the critical nuclei, the crystallization efficiency, the reactant addition rate, and the critical nucleus size. The BNG model consequently leads to an explicit, factor free model which quantitatively relates the number of crystals formed to reactant addition rate, crystal solubility, temperature, and the effects of crystal ripeners and growth restrainers. The consequences of these models on the process of practical crystallizations will be discussed.

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Biographical Abstract

Dr. Leubner received his Ph.D. in Science (Dr. rer. nat.) from the Technical University in Munich, Germany, with a major in physical chemistry and minors in inorganic and organic chemistry, and chemical engineering. After a Welch Research Fellowship at Texas Christian University in Fort Worth, Texas, he joined the Eastman Kodak Company in Rochester, NY. His publications on the mechanisms of spectral and chemical sensitization, and dopants resulted in the award of Fellowship and of the Lieven-Gevaert Medal, the highest science award in photographic science, by the Society of Imaging Science and Technology. His research and product development led to the controlled crystallization / precipitation of silver halides for the precision control of crystal size, morphology, and photosensitivity. His work contributed to accelerated product development and resulted in important contributions to the manufacture of improved products. For a full list of his publications, see www.CrystallizationConsulting.com and www.RochesterResearch.org .

Dr. Leubner has taught new concepts for the control of crystallization and precipitations at seminars, academic institutions, and industrial companies. These models have been successfully applied to the development of a wide variety of commercial products for his employers and clients. He applied the fundamental discoveries towards product development and lead teams to provide products with significantly improved features. As a consultant, Dr. Leubner applies his knowledge in precipitation and chemical sciences to help solve problems in industrial research, product development, and manufacturing. His clients include, in addition to his work at Kodak, Dow, Xerox, J&J, Cabot, Southern Clay Products, TempTime, Sachem, William Blythe, many other corporations, and presentations at academic institutions.