

Four Crystal Nucleation Models: An Evaluation for practical Applications

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To control the crystal size of a product it is desirable to have a theory based on fundamental science that allows simple modeling and accurate predictions. Four models have been proposed to relate the numbers of crystals formed to experimental parameters.

Of these, the classical model (1) is the best known, which focusses on nucleation rate.

The primitive (2), Klein-Moisar (3), and Balanced-Nucleation and Growth (4, BNG) models focus on the total number of crystals formed and on crystal size.

In the research lab, product development, and manufacturing, the control of crystal size and yield must be related to practical control parameters. These are temperature, crystal solubility, and reactant addition rate. Two other control factors are added active materials that decrease or increase the crystal size for otherwise fixed reaction conditions. For continuous crystallization, the residence time must be added as a control parameter. The four nucleation models will be presented and compared for application in research, product development, and manufacturing.

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Biographical Abstract

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 (England), Akzo (Netherlands) and many other corporations.

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. Subsequently he founded Crystallization Consulting to promote the knowledge and application of the balanced nucleation (BNB) model for precision control of crystallization in industry and academic institutions. His publications on the mechanisms of spectral and chemical sensitization, and dopants resulted in the award of a 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 included the controlled crystallization / precipitation of silver halides for the precision control of crystal size, morphology, and photosensitivity in film photographic systems. His work contributed to accelerated product development and resulted in important contributions to the manufacture of improved products. For a full list of publications, see www.CrystallizationConsulting.com and www.RochesterResearch.org.