

Preface

Numerous colloidal systems can be identified in nature. Many synthetic materials which are produced and processed are also colloidal systems. Such systems are always multiphasic and are mostly comprised of submicron particles or nanometer particles. The macroscopic properties of colloidal systems are governed by the microscopic interactions of its dispersed constituents with each other and with the surrounding dispersing medium. The properties of such particle systems are dominated by interfacial effects rather than volume effects because of their huge internal surface.

The focus of *Colloid Process Engineering* is on the handling of colloidal systems in technical processes and about their manipulation by such processes. Many branches in this field may find numerous pathways to rewarding new products with tailor-made properties. The economic success in global competition for any producer is based on the ability to establish products on the market with high and as yet unavailable beneficial properties at a competitive price. To meet these requirements, it is necessary to synthesize products with the targeted property profile through its complex structure as an integrated system. Colloidal systems offer unique opportunities for realizing such tailor-made integrated systemic products. *Colloid Process Engineering* is indispensable for the production of noteworthy amounts of such colloidal systems with relevance to the market.

Colloid Process Engineering is an emerging discipline at the interface between natural sciences, in particular colloidal and physical chemistry, and engineering, in particular chemical engineering. On the one hand, knowledge about molecular interaction and functional molecules is the key to controlling the microscopic interaction. On the other hand, process parameters, such as fluid dynamics, concentration profiles and mechanic forces, are decisive for structure formation and its preservation and functionality during application.

The articles in this book are aimed at scientists, researchers and developers in academia, science and engineering. This book is no true textbook or homogenized monograph. It is, rather, the compilation of the results of a recent cooperative research effort regarding *Colloid Process Engineering*. The effort was funded for six years (2008–2013) by the German Research Foundation.

It comprised an interdisciplinary team of 16 research projects and was carried out at various universities in Germany. Frequent seminars and workshops aimed at homogenizing perceptions, concepts and understanding of what *Colloid Process Engineering* may be about.

The book is structured along the headlines

- Fundamentals and Modeling
- Colloidal Systems with Solid Disperse Phase
- Colloidal Systems with Liquid Disperse Phase
- New Process Routes

The reader may find recent research results about various colloidal phenomena, as well as their scientific interpretation.

In *Fundamentals and Modeling*, answers are given to the questions why and under which conditions small molecules and self-organizing nanoscale particles stabilize emulsions and foams (Pickering effect) or emulsions form a gel. Advanced, non-linear rheological methods are proposed which allow the characterization of the structural parameters of colloidal systems and their changes in time. Furthermore, microscopic and fluid mechanic insights are given as to how colloidal aggregation in turbulent flow comes about and how such flows are to be modeled with up-to-date computational fluid dynamic approaches. The section closes with a chapter about the drying of colloidal systems and addresses the question of how drying affects the structure of a colloidal product.

In *Colloidal Systems with Solid Disperse Phase*, the restructuring of such colloidal systems is treated on a theoretical, an analytical and an experimental basis. Such restructuring may only be possible if an existing structure is destroyed. Therefore, mechanics and breakage of aggregates is addressed in this section as well. A high concentration of the colloidal system and its flow behavior is decisive for some applications. It is shown that weak attraction among the colloidal particles allows for unprecedented concentrations. Finally, formation, characterization, stabilization and post-processing of nanoparticles below 20 nm are addressed in this section. Such particle systems are needed for optoelectronic applications.

In *Colloidal Systems with Liquid Disperse Phase*, surfactants are needed to prevent the disperse phase from coalescing. The dynamics of the adsorption of surfactants at the interface during processing is of particular importance. Detailed and high-resolution measurements reveal that the mechanism of this adsorption comprises competitive effects among the various constitutive components of the system. Vesicles are peculiar, biomimetic liquid-liquid systems, in the sense that the dispersed droplets themselves are also a two-phase liquid-liquid system: They consist of a liquid core surrounded by a liquid shell. A systematic survey of preparation methods and an analysis of the physicochemical parameters required should help the interesting application perspectives of vesicles to become available.

In *New Process Routes*, two exemplary processes regarding the importance of process engineering aspects in the manufacturing of colloidal systems are treated. One of these process routes tracks the manufacturing of nanoscale core-shell particles via an emulsification process, followed by a miniemulsion polymerization for

the creation of a rigid shell. The other process route aims at the manufacturing of an organosol by transferring freshly produced mineral particles from the aqueous phase into the organic phase.

We are convinced that, in total, this spectrum of examples gives a unique insight into some important current frontiers of *Colloid Process Engineering*, and hope that reading these different articles will offer new insights into the world of colloidal process engineering or open the reader's mind to interesting process pathways in the colloidal world.

The editors of this book pay special thanks to Dipl.-Ing. Sebastian Wilhelm, who put a lot of effort into its preparation.

The financial support of DFG (Deutsche Forschungsgemeinschaft) within the priority program SPP 1273 "*Colloid Process Engineering*" is gratefully acknowledged.

Matthias Kind
Wolfgang Peukert
Heinz Rehage
Heike Schuchmann

Colloid Process Engineering

Kind, M.; Peukert, W.; Rehage, H.; Schuchmann, H.P.

(Eds.)

2015, XI, 398 p. 231 illus., 145 illus. in color., Hardcover

ISBN: 978-3-319-15128-1