

***Inorganic Particle Synthesis
via Macro- and Microemulsions***

***A Micrometer to
Nanometer Landscape***

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Nanometer Landscape***

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Foreword

“Nanotechnology” is now very well known as one of the most important key technologies in science and industry. In the field of material science and engineering, nanoparticles should be unit materials, as well as atoms and molecules, to build ceramics, devices, catalysts, and machines, and the “nanoparticle technology” is thus attracting. This novel technology includes various methodologies for nanoparticles: preparation, surface-modification via chemical and/or physical treatments, immobilization and arrangement on supports or substrates, to achieve high performance for luminescence properties in light emitting devices, and high efficiency for catalytic and photocatalytic reactions in chemical synthesis, chemical decomposition, and artificial photosynthesis, etc. It should be needless to say that the preparation of nanoparticles, having precisely controlled particle size, size distribution, chemical composition, and surface properties, is essentially important to realize “true nanoparticle technology”.

This book, written by Dr. Dibyendu Ganguli and Dr. Munia Ganguli, deals with the preparation methodologies for inorganic nanoparticles using macro- and microemulsions as “microreactor”. There are several differences between these two emulsions, in addition to water droplet size: thermodynamic stability, and fusion-redispersion dynamics of the droplets. The properties of the nanoparticles prepared in these emulsion systems are seriously influenced and controlled by the selection of dynamic and static conditions. This book should give effective information to readers who want to synthesize nanoparticles in these microreactors, since the authors give not only published results in the large quantity of literature referenced, but also the potential, advantages, limitations, and disadvantages of this methodology, as well as basic properties for these microreactor systems. Scientists and engineers, who want to participate in the field of nanoparticle technology, should refer to the complete picture given in this well-organized book.

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Preface

Solid particles of different inorganic substances constitute the basic ingredients of a variety of materials and devices, and are therefore the mainstay in many activities in materials science and technology. Bulk ceramics, thin and thick films for sensing, luminescent and other devices, catalysts – all need particles of various sizes, if not also of various shapes. As a result, synthesis of inorganic particles has always remained an important activity in materials science and new and improved methods of synthesis are being developed and tested.

Macroemulsions are well-known for their manifold applications in the chemical industry; their role in inorganic particle synthesis came to be realized and appreciated somewhat recently. However, macroemulsion-mediated synthesis is now an important route, targeting not only micron-sized particles, but also nanoparticles. Microemulsions and their unique nature became known through the phenomenon of “solubilization” and the practical implications were also evident almost simultaneously. Apparently, the first synthesis of tailored inorganic nanoparticles through microemulsions was reported about twentyfive years ago. Since then, the method has grown into one of the best known and most elegant ways of controlled synthesis of oxide and non-oxide nanoparticles of a range of sizes and shapes.

A strong interest in macro- and microemulsions, i.e. their formation, stability and other properties, as also their use in inorganic particle synthesis (especially in case of microemulsions) became evident in the last few decades through a large variety of scientific publications and meets across the world. It was, however, felt by the present authors that there is no single and simple book available which introduces this broad-spectrum subject of macro- and microemulsions from the angle of particle synthesis in a way that is governed by practical necessities. This work therefore plans to fill this overlooked void by including only the necessary basic details in this respect and a large number of examples for the reader to see the versatility, as also for selection from when synthesis is planned. It is hoped that the book will meet these requirements.

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While the writing of the book was in progress, the spouses and other family members took care of most of the other activities in the two households. Shibani Ganguli and Shantanu Chowdhury deserve our special appreciation for having taken up the relievers' tasks so eagerly and understandingly.

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