1
General Introduction

Günter Schmid

Six years after the publication of the First Edition of *Nanoparticles*, in 2004, the Second Edition became necessary due to the impressive developments in the important field of nanosciences and nanotechnology. Today, the predictions made in the "General Introduction" in 2004 have, more or less, all been confirmed. In other words, developments with regards to the study and application of nanoparticles have made decisive progress, and nanotechnology in the broader sense has today become a general expression for technical progress which, in public discussions, is often used in a scientifically incorrect sense. Nevertheless, the public have become very much aware of these new techniques, and have accepted them to a great extent.

This Second Edition of *Nanoparticles: From Theory to Application* is, of course, based on the construction of the First Edition, with most of the chapters having been considerably renewed, extended or even totally rewritten, largely as the result of scientific progress made during the past six years.

The changes in Chapter 2 on "Quantum Dots" are only marginal, as the original chapter contained mainly the basic physical facts regarding the nature of nanoparticles; however, some new relevant literature has been added. Chapter 3, on "Synthesis and Characterization" begins with a new Section 3.1 on "Homoatomic and Intermetalloid Tetrel Clusters," a contribution which contains details of the latest results in the field of the famous Zintl ions (especially of Ge, Sn, and Pb), although those with endohedral transition metal atoms are also considered. Particular importance is attached to inter-cluster relationships, to form oligomeric and polymeric nanostructures. The following Sections 3.21–3.23, on "Semiconductor Nanoparticles," have been adjusted to the development of literature. In particular, those sections on Group II–VI and Group Ib–VI semiconductor nanoparticles are now complemented by the latest published results. Both, Section 3.3.1 and Section 3.3.2, on the synthesis and characterization of noble metal and magnetic nanoparticles, respectively, have consequently also been renewed and extended, following the preconditions of literature. The same is valid for Chapter 4, which deals with the "Organization of Nanoparticles." The increase in knowledge concerning "Properties," in Chapter 5, differs depending on the systems to be considered. While the progress of "Optical and Electronic Properties of Group III–V and Group

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II–VI Nanoparticles" (Section 5.1.1) is obviously limited, that of Group Ib–VI nanoparticles (Section 5.1.2) is much more marked. There has also been a considerable increase in information concerning the "Electrical Properties of Metal Nanoparticles," as can be seen from the extended Section 5.2. Finally, it must be noted that nanoscience and nanotechnology have definitely arrived in the biosciences, including medicine. Therefore, the former Chapter 6 on "Biomaterial–Nanoparticle Hybrid Systems" has been quantitatively substituted by a new chapter "Semiconductor Quantum Dots for Analytical and Bioanalytical Applications." Semiconductor quantum dots, meanwhile, have acquired a decisive role as molecular sensors and biosensors, due to their photophysical properties. Fundamental studies conducted during the past few years have demonstrated the ability of semiconductor quantum dots to act as biosensors, not only as passive optical labels as in the past but, based on the progress of molecular and biomolecular modifications, as indicators of biocatalytic transformations and conformational transitions of proteins. Comparable progress has been achieved in the field of chemical sensors, such that specific recognition ligands are now capable of sensing for ions, molecules, and macromolecules.

Altogether, this Second Edition provides an actual insight into the present situation on the development of metal and semiconductor nanoparticles.

It should be mentioned at this point that not all aspects of the world of nanoparticles can be considered in a single volume. For instance, the rapidly developing field of nanorods and nanowires has again not been considered, as these species are indeed worthy of their own monographs. The terminus "Nanoparticles," as in the First Edition, is restricted to metal and semiconductor species. Numerous other materials exist as nanoparticles, while nonmetallic and oxidic nanoparticles exist and exhibit interesting properties, especially with respect to their applications. Nevertheless, from a scientific point of view, metal and semiconductor nanoparticles play perhaps the most interesting role, at least from the point of view of the Editor.