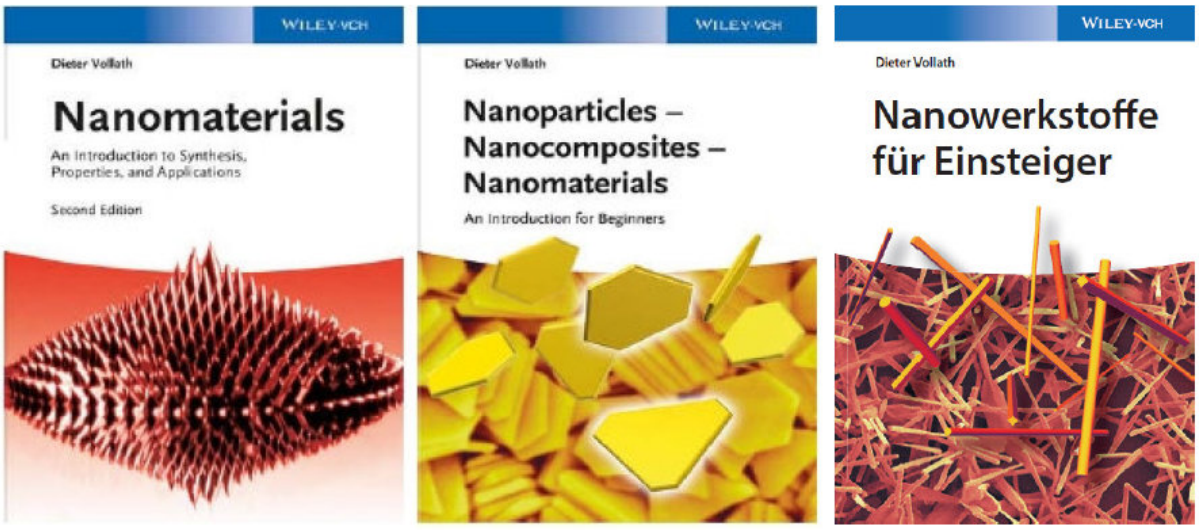
Course Nanomaterials

Content of the course

The content of NanoConsulting courses is always on the state of the arts, as it is updated twice a year. You will get a broad overview on properties and fabrication processes of nanomaterials. Especially mechanical, optical, magnetic, and electric properties are taught. Phases, phase transformations, and related phenomena as function of the particle size are discussed in detail. This is always done in view of technical applications. Therefore, examples, such as nanofluids, superparamagnetic cooling, self-cleaning surfaces, or nanomotors, introducing to the wide field of nanotechnology are presented. Additionally, the criteria for economic successful technical applications will be explained. Each participant has the chance to ask questions important to his company.



I promise: I will not bother the participants with pure theory or mathematics, which is not understood generally.

Who should attend?

This course is directed to employees of small and medium-sized companies, intending to improve their products by the application of nanomaterials or is determined to develop new ones based on nanomaterials. The second group to order this course are companies, universities or research institutes who want to shorten the time to get the necessary knowledge on nanomaterials or those who want to broaden their knowledge in this group of materials.

Course overview

Timing

Generally, the standard course lasts three days. The lectures are held daily from 8:30 to 12 and 2 p.m. to 5:30 p.m. with a coffee break in the morning and the afternoon session. Each of these blocks consists of two lecturing units (LU). Within three days, five half days are devoted for lectures and discussion, one half day is reserved for discussion or group work and presentation of the workshop results. In the evenings, there is the possibility to discuss open questions in a relaxed atmosphere. The topics outlined in the following section may be altered according to the preferences of the audience.

Technical content

Introduction

After an introduction to the economic background, the course starts with an explanation of the terms and concepts, such as e.g. nanocomposites. In this context, a few related applications are discussed. (2 LU)

Consequences of small sizes

The consequences of nanosized particles are explained. Most important are the huge surface/volume ratio and the influence of size on diffusion phenomena. This has severe consequences with respect to coagulation and phase transformations, e.g. melting. These topics lead to technical applications exploiting these phenomena (sensors). (1 LU)

Synthesis and sintering

The most important processes for synthesis are discussed. Within this framework, gas phase processes are essential. Besides conventional processes, plasma and flame processes are crucial subjects. Very interesting and of economic importance are processes delivering coated particles within one step and hints for optimization of the synthesis. The influence of small particle sizes on sintering is explained in detail; especially the interplay of densification and grain growth is analyzed. (4 LU)

Mechanical properties

The new mechanical properties of these materials are explained. In this context, the inverse Hall-Petch phenomenon is of special interest. Composites with polymer matrix, where the nanostructured phase consists of particles, fibers, or platelets are of technical importance; especially those filled with silicate platelets, as they are flame retardant. (1 LU)

Surface influenced behavior

This unit explains the influence of the large surface of the particles on the properties. In detail, the influence on material transport, heat capacity, phase transformations, and fluctuation phenomena are topic of this unit. (1 LU)

Magnetic properties

Nanomaterials are the basis for a series of improved magnetic materials. After a general introduction to magnetic materials, the new soft ("superparamagnetic") and hard ("exchange coupled") magnetic materials are explained. These new materials are leading to applications of economic importance. (3 LU)

Optical properties

The influence of the small particle size on light scattering, absorption, and emission is topic of this unit. Essential, with respect to technical applications, is the behavior of quantum dots and plasmons, which control the emission and absorption of light. In view of new applications, nanocomposites with special optical properties, e.g. the new bifunctional opto-magnetic materials with high potential of application, are of special importance. Finally, phenomena like electroluminescence (OLED), electro-, and photochromic behavior are explained. (4 LU)

Fullerenes, carbon nanotubes, graphen, and related materials

These materials are special cases of a general class of compounds with layered structures. Within these units, the most important carbon structures and their very special properties are explained. Among others, these properties are exploited in nanocomposites with polymer matrix leading to materials with very special electrical, optical, and mechanical properties. Additionally, compounds of this class based on sulfides of molybdenum and tungsten are successfully applied as additives for lubricants. (2 LU)

Technical applications

Finally, the technological important nanofluids and ferrofluids, together with their important applications are introduced.

New technological developments leading to printable electronics, field emission displays, nanomotors, and nanostructuring are topics of the final lectures, too. (2 LU)

Group work

If requested, on the afternoon of last day, the participants are asked to form groups, developing ideas in a field of their interest. The results of the working groups are presented and discussed in detail.

Alternatively, questions of the participants or other problems in connection with applications may be discussed.