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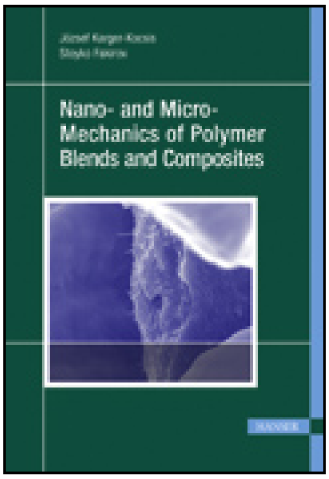

Preface

Nano- and Micromechanics of Polymer Blends and Composites

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Preface

The deduction of *structure-property relationships* is a major target of materials scientists. Unfortunately, these relationships are hardly ever universal, but mostly of specific nature. On the one hand, this is due to the fact that there is no correlation between the structural units in different materials, such as metals, ceramics and polymers. On the other hand, the materials have a very complex structural build-up, the constituents of which are strongly interrelated. This note holds especially for polymers.

Depending on the size of the volume elements which contain all structural "inhomogeneities" in a way that *via* their combination the related material can be treated as "homogenous" (representative volume element concept), one may distinguish between macro-, micro- and nanocomposites. The size of the representative volume element in *macrocomposites* is in the range of millimeters and above. Such polymer macrocomposites, as those with various textile architecture (woven, braided), resin infiltrated open cell metallic and ceramic foams *etc.,* are beyond the scope of this book. The term polymer *microcomposite* covers very different systems, accepting the definition that at least one dimension of the constituents is in the micrometer range. So, unidirectional aligned carbon (diameter 6–7 μm) or glass (diameter 10–15 μm) fiber reinforced composites, neat polymers with injection molding-induced skin-core structure (oriented skin layer thickness is usually less then 200 μm), polymer blends and reinforced/filled polymers having microscale inclusions (at least in one dimension again!) – all belong to this category. In the case of *nanocomposites,* at least one dimension of the constituents should be on the nanoscale (such as clay or carbon nanotubes). As mentioned above, the structure of polymers may be very complex and multiscaled. For example, fiber-reinforced microcomposites with a nanomodified matrix or semicrystalline polymers themselves (just consider the mean sizes of spherulites and crystalline lamellae) are on the borderline between micro- and nanocomposites. This may be the reason why polymer scientists often use the term morphology instead of micro- and nano-scale structures for neat polymers.

The structural elements of *one-component multiphase systems* (homopolymers and copolymers) are in the same size-range as nano- and micro-sized additives and reinforcements of the *multicomponent systems* (blends and composites). This fact makes possible the application of the same characterization techniques and modeling approaches to these rather different, from material point of view, systems. What is more, the structural elements in the homopolymers and copolymers as well as the constituents of the blends and composites are distinguished by their individual mechanical characteristics and each of them makes its own contribution to the overall mechanical behavior of the whole system. At the same time, multicomponent systems, as a rule, can be considered multiphase systems as well. Only in rare cases, when a particular property obeys the additivity law, the complex system can be easily predicted with respect of this property. In the rest of the cases, empirical approaches and modeling have to be applied for the deduction of structure-properties relationships.

With the appearance of polymeric nanocomposites, the structural build-up of polymeric materials, including polymeric microcomposites, has become even more complex. This has forced the researchers to check whether or not the knowledge acquired with traditional microcomposites can be transferred to nanocomposites, produced by different methods. As the reader will notice, this is sometimes the case for structural polymeric micro- and nanocomposites. On the other hand, polymer nanocomposites may show peculiar properties that are not present, not even in analogy, in microcomposites. To find the cause of such behavior is a very challenging task, which requires a *multiscale approach.* The latter covers in-depth structural investigations as well as molecular modeling using different approaches and techniques.

Our aim with this book is to demonstrate that the *multiscale approach* is the right tool for a deeper understanding of the structure-property relationships in polymeric micro- and nanocomposites. The term "mechanics" in the title is foreseen to demonstrate that emphasis has been put on structural instead of functional composites. Note that the mechanical behavior of structural composites is of great practical relevance and the driving force of their development nowadays. The book contributions are grouped in 5 sections. Part I is devoted to polymers (Galeski and Regnier and Ginzburg *et al.).* Part II highlights selected aspects of composite production (Zhang *et al.,* Bokobza, and Bhattacharyya and Fakirov). Part III considers interphase aspects (Kalfus and Jancar). Part IV gives an overview of characterization methods and properties, including *in situ* deformation (Stribeck), creep and fatigue (Pegoretti), deformation and fracture properties (Tjong, Dasari *et al.* and Karger-Kocsis), and hardness (Fakirov). The book ends with Part V dealing with modeling of rubber and polymer nanocomposites (Mark *et al.* and Spencer and Sweeney).

Our intention was to cover all kinds of polymeric materials, *viz.* thermoplastics, thermosets, and rubbers, including their different types and combinations.

We are thankful to our contributors for their high quality chapters and their timely delivery. We strongly hope that you, the readers, will find this book useful for your work.

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