Introduction

The carbon atom is an essential building block in nature; it is at the origin of life on our planet especially because of the complexity of its chemical bonds. It can also self-assemble in different ways producing numerous solids and materials. Although some have been known for a long time, such as diamond and natural graphite, research in the last 50 years has uncovered other new materials reported as polymorphs. These significant advances constitute an example of the mutually beneficial exchange between science and technology. The rate of knowledge expansion on this topic has sometimes led both researchers and engineers to think that some discoveries were made several times. Hence, we decided to integrate the most recent advances historically, and this was the driving force behind the preparation of this book. To achieve this, the book has been divided into three parts. The first presents five chapters focusing on the allotropic forms of carbon, including their precursors and closely related analogs. The second part focuses on their intrinsic properties, and the third describes the applications of carbon-based materials. The themes and contents are summarized in the table of contents. In the first part (Chapters 1 to 5), we define and describe natural forms of carbon, referring in particular to the allotropes of graphite and diamond, as they are the basis of the newly discovered molecular phases, which include carbynes, fullerenes, and planar or rolled-up graphene sheets. This part is based on thermodynamic and structural characteristics of these phases and is further developed based on concepts borrowed from solid-state physics. Later, the comparison of properties between polymorphic varieties is reported (Chapters 6 to 10) according to a solid-state physics approach. Finally, the last part focuses on materials, introducing the physical chemistry of surfaces and interfaces when exposed to their environment (Chapters 11 to 15). These materials, which are the result of human development, were created to exploit a physical property or specific chemical functionality corresponding directly to the

desired application. We will demonstrate that this area of material science is highly dependent on the evolution of our society and its economy including the current developments of nanosciences and nanotechnologies.

The structure of this section is based on a historical approach that integrates several key references used throughout the whole book. The full list of general references is provided at the end of this introduction; it appears in chronological order commencing with the book by Henry Le Chatelier, which was published more than a century ago and pioneered the description of the different carbon-based phases. The collective manuscript on carbons, published in the 1960s in France has been a benchmark ever since. However, recent developments, in particular the case of the new molecular phases and their properties, have instigated the requirement for new research in order to describe them appropriately. Some theoretical reminders on physics of the solid can be found in various sections, as well as descriptions of the most relevant characterization techniques associated. Thus, in this well of knowledge containing "theory-technique-subject" we have focused on solids and carbon-based materials. It is suggested that the interested reader complement this with a list of less specialized books and websites (see for example Wikipedia online).

In terms of nomenclature we adopted the terminology recommended by IUPAC (E. Fitzer, K.H. Kochling, H.P. Boehm and H. Marsh, publication DKG n° 32, 1998). The main abbreviations and symbols as well as the keywords used are listed in two different indexes. Moreover, in each chapter the most recent and historically significant publications are listed in an effort to highlight the progress in each field of interest. A non-exhaustive and highly subjective approach has been employed in order to establish a classification based on the different varieties of carbon instead of developing each specific property. Finally, we have decided not to highlight the diverse utilizations and industrial applications of these materials (no reference to any patent), which are in constant evolution, but instead to provide an overview of the basic notions used and their evolution with time.

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carbon materials started in the sixties by Adolphe Pacault and André Marchand at Bordeaux. The influence of the scientific community belonging to the French carbon group has also been tremendous with its annual meeting where exchanges and discussions are always intense.

Concerning the manuscript preparation I am deeply grateful to Michel Trinquecoste and Stéphane Reculusa for the illustrations, then to Nicolas Nouvel for the English translation which has been updated and improved, correcting some mistakes present in the French edition. I finally dedicate this book to my wife Christiane Delhaes, our children and grandchildren, who have kindly followed all the steps of this project.

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