Preface

It would be a misstatement to claim that this title provides an "exhaustiveness" coverage of the world of ceramic materials, if only because this subject covers such a wide area that only one book would not be able to do it justice – even if it is supplemented by a book dedicated to ceramic composites and by several volumes devoted to the cousins of ceramics, namely glasses, cements and concretes, and geomaterials. However, we believe that this problem can also be an advantage, because it resulted in the production of a concise work that provides the essence of the subject. In fact, initially this book was written for non-ceramists – students and engineers – interested in an introduction to the knowledge of this vast family of materials, in other words, for readers whose interests are not limited only to ceramics but for those who are aware that ceramics can act as a support (often) or as a rival (sometimes) to other materials.

The necessity of concision has led to some restrictions. We have eliminated recapitulations, for example, thermodynamics or crystallography; we have not discussed materials that seemed far from the interests of our potential readers, such as monocrystals (jewelry and technical uses), ceramics for chemistry (catalysis and filtration), or superconductive oxides; finally, we have not dealt with "black ceramics" (graphite and carbons) or with deposits of diamond or hard carbon.

As regards the division of this book into two parts, our choice was to devote the first part to the fundamentals of *materials* and *processes* and to devote the second to *properties* and *applications*. An essential difference between metals and ceramics lies in the fact that, for the former, there is generally a separation between the industry that produces the *material* (for example, in the form of sheets) and the industry that manufactures the *part* (for example, the car body structure), while, for the latter, it is the same ceramist who is in charge of manufacturing, almost simultaneously, both *the material and the part*.

This explains why, in Part 1, we have given an important place to *production processes*: raw materials, processing of powders, forming and, finally, sintering (Chapters 1, 3 and 5).

Being materials older than metals and materials that had experienced unequalled aesthetic and technical successes before metals (the porcelains of China), ceramics become more interesting, even in their latest forms, when observed from a viewpoint that does not exclude history. We have therefore presented ancient ceramics (Chapter 2), as well as silicate ceramics – ceramics that are wrongly described as "traditional", a term which could conceal the permanent innovations that they undergo (Chapter 4).

"Technical ceramics" (to use another commonly used term) are mainly oxides (Chapter 6), but non-oxides (chapter 7) have recently experienced a number of developments. The presentation of the main compounds – oxides and non-oxides – throws light on the characteristics and therefore the potential uses of the corresponding materials, which opens the way to the second part devoted to properties and applications.

In Part 2, Chapter 8 describes the mechanical properties of ceramics by emphasizing the specificities of these materials. The fields of abrasion, cutting and tribology highlight the importance of mechanical properties, *cermets* (Chapter 9) here bridging the gap between the world of CERamics and the world of METals. Refractories (Chapter 10) widen the requirements by combining mechanical stresses, the effects of high temperature and severe chemical aggressions.

It is not just structural materials which require satisfactory mechanical properties; functional materials are also demanding: broken spectacles no longer correct vision and henceforth manufacturers of spectacles work mainly to obtain better resistances to scratches rather than fine-tuning optical performances! We have therefore given functional ceramics their due, and particularly ceramics for electronics (Chapter 11) which represent the bulk of "technical ceramics".

Bioceramics (Chapter 12) also illustrate the complementary nature of structural performances and functional performances: high mechanical properties are required but these should not enter into conflict with biocompatibility. If necessary, these must even disappear from the pedestal of bone reconstruction; this richness and complexity in behavior could not be ignored.

France is one of the largest electronuclear countries and the nuclear world is the perfect example for the interlacing of questions and answers that a ceramist could encounter: this forms the subject matter of Chapter 13.

Lastly, chemistry forms a basic discipline for ceramists, particularly when it requires making materials as demanding as materials in optical applications: Chapter 14 describes the contribution of "soft chemistry" with the help of sol-gel methods.

Ceramics show that diversity and unity are not contradictory. The compounds are multiple, the applications are varied, the properties brought into play are different, even contradictory – ceramic oxides range from superconductors to the best electrical insulators. However, the chemistry of the systems brought into play, the nature of the interatomic bonds and, from the engineer's view point, the production processes serve as the connecting point. Naysayers could suggest that there is another common point (and which, worse, is a weak point): brittleness. It is true (except at high temperatures where it is creep that poses problem), but I believe our readers are informed enough to understand that the term "brittle" (in the meaning of "non-ductile") is a bad quality only for those who do not understand its profound significance. As Chapter 8 shows, brittleness is a hydra that can be controlled and, moreover, it is the price to be paid for high modulii of elasticity and high hardness. The horizontal vision (*materials science and materials engineering*) of the Anglo-Saxons offers the advantage of including within a single vast landscape metals, polymers and ceramics – a term then understood in its broadest meaning of "non-metallic inorganic solids". In this vision, the varied characteristics of materials are less seen as "strong points" or "weak points" than as givens, admittedly often exclusive of each other, but the comparison of usage specifications makes it possible to select them as effectively as possible.

Having begun my scientific career with the study of metals and continuing to cooperate with metallurgists, surrounded by polymerist colleagues, then having become a ceramist and now particularly interested in cementing materials, filled with wonder for minerals – they are beautiful and efficient and show all that we can achieve if we had enough time and if we could work more easily under high pressures – I am persuaded that it is by comparing materials with one another that we can best understand them. I hope that this book on ceramics becomes the tree that does not hide the forest.

Philippe Boch

At the time where the French version of this work would have to become the English version, Philippe had to leave us on the bad side of the forest. I became in charge of the tree.

Philippe, the English version of your book on ceramics is now ready; I hope it is faithful to that you wished and that the tree is now on the right side of the forest.

Jean-Claude Niepce