PREFACE

Developing oxide-graphite composite refractory is a significant challenge to the improvement of the resistance to slag intrusion, thermal shock resistance, and structural spalling resistance. The aim of this work was set to develop efficiently and practical new methods to incorporate nanocarbon black (NCB) replacing flake graphite (FG) into the Al_2O_3 based bricks for iron and steel making applications. It can minimize the adverse effects associated with the anisotropy and oxidation of FG, and optimize overall properties of these carbon-containing refractory bricks (CCRB's).

Few commonly used antioxidants is studied comparatively and in a combination with each other to deduce an optimum content and blend. These approaches were put into effect as countermeasures against the problems caused by FG in order: 1) to diminish the density difference by using NCB-FG mixture; 2) to modify the surface area and reactivity by a high energy ball milling and respective mechanical activation of the antioxidants; and 3) to use appropriate antioxidants combination to inhibit the oxidation of FG.

Alumina-magnesia-carbon containing bricks suffer from their internal volume expansion during service. It is due to the *in situ* spinelization. An optimized content of mechanically activated magnesia was found to improve the situation. Another hybrid type composition containing both *in situ* and pre-formed spinel had a much better slag corrosion resistance.

In my work, I faced the problem from different sides, using many analytical techniques to study the changes occurring both in the material and in the formulation, although the main focus of the work was the analysis of changes in the material. Nevertheless, this type of study is still quite limited; especially if compared with the years-long research carried out on the properties magnesia-carbon refractories. I hope that the following work may contribute extending the service life of these refractories.

The subject matter of the thesis is divided into the following eight chapters:

- **Chapter 1** is the introduction, literature review of and objective of the present research work, comprising of a general introduction of steelmaking refractories.
- **Chapter 2** presents the materials and methods which are used in present research work with detail.
- **Chapter 3** is a research work related to the addition of nanocarbon black replacing the flake graphite in Al_2O_3-C refractories. Studies on their structural, physicochemical and thermo-mechanical properties, have been included.
- **Chapter 4** discusses the role of Role of particle size and amount of antioxidants on the durability of Al_2O_3-ZrO_2-C for flow control applications of secondary steelmaking.
- **Chapter 5** is devoted to studying the influence of a combination of oxidation inhibitors in Al_2O_3-SiC-C for the torpedo ladles. Three different combinations of antioxidants are comparatively studied.
- **Chapter 6** displays the effect of mechanochemically activated MgO in Al_2O_3–MgO–C for the sidewalls and bottom of a ladle refining furnace.
- **Chapter 7** presents a hybrid Al_2O_3–MgO–C refractory containing *in situ* and pre-formed spinel both for a better volumetric stability and dimensional control while in the application.
- **Chapter 8** combines the overall conclusive statements of all the works as mentioned chapter wise. It is finally followed by references and list of publications and their reprints.