PREFACE

The term 'High Alumina Cement' (HAC) came into use when this type of cement, containing 32-45 % alumina was introduced in the UK after World War I. It was distinguished from Portland type cements which contain less amount of alumina. Subsequently, many other aluminous cements have been developed with varying alumina contents between 50-90%, mainly for refractory purposes. The common characteristic of this type of cement is that the reactive phases and hydrates formed during hydration are essentially of calcium aluminate. Therefore, they best referred to collectively as high alumina cement.

High alumina cements are obtained by calcination and/or fusion of a mixture of argillaceous and calcareous materials with suitable proportions and finally grinding the sintered products to a fine powder. In comparison to Portland cements, the annual production of high alumina cements is very small and they are also considerably more expensive. Therefore, they do not compete directly with Portland cements in everyday applications. However they have several unique properties which make them the materials of choices in special applications, where the performance of Portland cement is insufficient. When used in conventional concrete, these properties include rapid strength development at low temperature, high temperature resistance and resistance to a wide range of chemically aggressive conditions.

A significant advancement in monolithic technology was the development of refractory concretes or castables based on high alumina cements (HAC's). Castables are complex refractory formulations, requiring high-quality precision-sized aggregates, modifying fillers, binders and additives. The majority of castables contain a HAC binder. The conventional castables, which contain the largest amount of cement, still make up the greatest percentage of those produced. The use of reduced content of cement in castables, termed as low cement castables (LCC's) and ultralow cement castables (ULCC's), has grown significantly over the past 10 years. This is due to the fact that the CaO, present in high content of cement based castables, leads to deterioration of high-temperature properties. They may be cast in molds to form specific products (pre-cast shapes) or cast "in place", as when forming a lining for a kiln furnace. The main technical advantages of LCC's and ULCC's are their excellent physical properties, such as high density, low porosity, high abrasion, high corrosion resistance, high cold and high temperature strengths,. Many attempts are being made to improve the thermo-mechanical properties of refractory castables by reducing the cement content, using proper qualities of aggregates and also by improving the quality of cement.

In practice high alumina cement is being prepared at high temperature (~1600°C). Therefore, in this thesis, investigations were aimed to prepare high alumina cements at relatively lower temperatures starting from 1000°C by utilizing four different processes. These powders were tested for cementing and other physico-chemical properties. The prepared cements were further utilized in the casting of monolithic refractory samples. These castables were characterized for their crystallinity, physical, chemical and thermal properties.

The subject matter of the thesis has been divided into the following seven chapters:

- **Chapter 1** is the introductory part of the research work, comprising of a general introduction of high alumina cements. Classification of cements is presented based on its mineralogical composition, preparations techniques and its implementation as hydraulic binder in monolithic refractory.

- **Chapter 2** presents the fundamentals of present research work with detailed literature survey, starting from history of development of high alumina cements to their implementations in castable refractories.

- **Chapter 3** is a compiled research work related to the synthesis of high alumina cements using a gel-trapped co-precipitation process and their characterizations. Further, studies on their implementations as bauxite based low cement castables with addition of micronized ZrO_2 have been included.

- **Chapter 4** discusses the synthesis of high alumina cements by employing a novel co-melting process. Their implementations as bauxite based low cement castables with some additives, like SiC, reactive Al_2O_3 and micro fine SiO_2, have been studied

- **Chapter 5** is devoted to the synthesis of high alumina cements via an auto-combustion process and their implementation as bauxite based low cement castables with additions of micro fine MgO and Cr_2O_3.

- **Chapter 6** displays the synthesis of high alumina cements by a mechanochemical process and their implementation as bauxite based low cement castables, Effect of additives, such as α-Al_2O_3, ZrO_2 and SiC, in castable formulations have been studied.

- **Chapter 7** combines the overall conclusive statements of all the works as mentioned chapter wise. It is finally followed by references, list of papers published and the general profile of the candidate.