

Quantitative Determination of the Amorphous and Crystalline Phases of the Ceramic Materials

C. T. Kniess^{(1,2)*}, N. C. Kuhnlen⁽¹⁾, H. G. Riella⁽¹⁾, P. B. Prates⁽³⁾, J.C. de Lima⁽⁴⁾, E. U. C. Frajndlich⁽⁵⁾

- (1) Federal University of Santa Catarina (UFSC) - Chemical Engineering Department - Florianópolis, SC, Brazil - e-mail: kniess@enq.ufsc.br
- (2) Ibirapuera University (UNIB) - São Paulo, SP, Brazil
- (3) Federal University of Santa Catarina - Mechanic Engineering Department
- (4) Federal University of Santa Catarina - Physics Department
- (5) Institute of Energy and Nuclear Research (IPEN) - São Paulo, SP, Brazil

* Corresponding author.

Abstract – This study is about the quantitative determination of the amorphous and crystalline phases of the ceramic materials developed with addition of the coal bottom ash. The quantitative determination was realized utilizing the X ray diffraction technique, through the methods proposed by Rietveld¹ and Ruland².

Fly and bottom ashes are byproducts originating from the combustion of coal in thermoelectric power stations. The fly ash residue has been used in the cement industries, while the bottom ash up to now has no industrial applications. The later residue represents almost 50% of the total generated by the thermoelectric plants. The physical, chemical and mineralogical characteristics of bottom ash are compatible with many raw materials used in the ceramic tiles industry, which indicates the possibility for the partial or total substitution of these raw materials with this byproduct.

Ceramic materials have properties defined by their chemical and micro-structural composition. The quantification of the amorphous and crystalline phases is a fundamental stage in the determination of the structure, properties and applications of a ceramic material. Within this context, this study aims is the quantitative determination of the amorphous and crystalline phases of the ceramic materials developed with addition of coal bottom ash, utilizing the X ray diffraction technique, through the methods proposed by Rietveld¹ and Ruland². For the formulation of the ceramic mixtures a {3,3} simplex-lattice design was used, giving ten formulations of three components (two different types of clays and coal bottom ash). The crystalline phases identified in the ceramic materials after sintering at 1150°C during two hours are: quartz (α -SiO₂ – JCPDS³ 05-490), polymorph of SiO₂ (SiO₂ - JCPDS³ 76-912), trydimite (SiO₂ - JCPDS³ 75-638), mullite (Al_{2,35}Si_{0,64}O_{4,82} - JCPDS³ 15-776) and hematite (Fe₂O₃ - JCPDS³ 13-534). The proposed methodology for the use of the Rietveld method for the quantification relating to crystalline phases together with the Ruland method used for the determination of the crystallinity of the materials was shown to be adequate and efficient.

References

- [1] H. M. Rietveld, *Journal of Applied Crystallographic*, 65-71, 2 (1969).
- [2] W. Ruland, *Acta Crystallographic*, 1180-1185, 14 (1961).
- [3] JCPDS (*Joint Committee of Powder Diffraction Standards*). International Centre for Diffraction Data. Pennsylvania, USA., (1981).