08-003

Study of phosphate glasses produced from natural phosphorite

De Souza, J.P., Martinelli, J.R.
IPEN

Phosphate based glasses have been intensively investigated because they can be used in a wide range of applications, such as rare-earth host ions for glass lasers, optical fibers and lenses, hermetic sealing, electrodes, leaching devices applied to agriculture, and matrices for immobilization of nuclear waste. The advantage of phosphate glasses for immobilization of nuclear wastes is that they can solubilize wastes containing phosphorus and sulfur. The structural basis of phosphate glasses is a tetrahedral formed by a phosphorus atom in the center bond to four oxygen atoms located at the corners. The present work investigates the use of a mineral known as phosphorite which contains phosphorous and other components such as CaO, Fe2O3, SiO2, Al2O3, MgO, and F, as raw material for the production of phosphate glasses replacing chemical compounds with higher value. Phosphorite was mixed with different amounts of sodium phosphate, and melted in the temperature range of 1050 °C - 1250 °C, using alumina crucibles. The liquid was poured in a stainless steel mold, or into water. The resulting material was analyzed by X-ray diffraction (XRD), X-ray fluorescence spectrometry, differential thermal analysis and leaching tests to determine the glass chemical durability. The density was determined using the Archimedes principle and the He gas pycnometry. Samples were also analyzed by FTIR, and the dilatometric curve was determined in the temperature range of 20 - 900 °C. A preliminary composition containing 50 wt% of phosphorite and 50 wt% of NaH2PO4 was investigated. Peaks related to the presence of crystalline phases were observed in the XRD pattern. A second composition containing 67 wt% of phosphorite and 33 wt% of NaH2PO4 was also studied and according to the XRD data the material is amorphous. The coefficient of linear expansion of the material is 22.2 ppm/ºC and the softening temperature is 445 ºC according to the dilatometric curve. The coefficient of linear thermal expansion of this glass is relatively high compared to other glass and ceramic materials. The glass transition temperature is in the range of 498-512 °C. The maximum temperature of crystallization is 657ºC. The composition containing 33 wt% of phosphorite seems to be the most potential material for different applications. Density was determined before and after heat treatments for crystallization of the material (650 °C/24h). Hence it is possible to use phosphorite to obtain phosphate glasses when sodium phosphate is added which makes possible the melting of the components.