STUDIES OF CALCIUM ORTHOSILICATE POLYMORPHISM BY DIFFERENTIAL THERMAL ANALYSIS

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The polymorphic transitions of calcium orthosilicate have been studied by means of differential thermal analysis. The parameters of $\beta$-Ca$_2$SiO$_4$ synthesis without stabilizers have been established.

The similarity of the crystal structures of calcium orthosilicate and alite, the analogous hydration mechanisms and the relatively low temperature of Ca$_2$SiO$_4$ synthesis are the reasons for the investigation of binders containing Ca$_2$SiO$_4$ as a main component. $\beta$-Ca$_2$SiO$_4$ is the polymorph with the best hydraulic properties. This phase is metastable in the whole temperature range and can be stabilized by the addition of certain impurities, viz. B$^{3+}$, P$^{5+}$, Cr$^{6+}$ or As$^{3+}$. Pritts and Daugherty [1] proved that these stabilizers lower the rate of Ca$_2$SiO$_4$ reaction with water.

The aim of this work was to determine the parameters of $\beta$-Ca$_2$SiO$_4$ synthesis without the utilization of stabilizers. The $\gamma$-Ca$_2$SiO$_4$ of high purity produced during the long-lasting heating at 1500° of a mixture of CaCO$_3$ + silica gel was used as starting material. The $\gamma$-Ca$_2$SiO$_4$ phase forms characteristic aggregates of thin needles and plates covered with a network of cracks.

The DTA studies were carried out using a Setaram thermoanalyser and revealed, during heating and cooling, all the peaks corresponding to Ca$_2$SiO$_4$ polymorphic transitions as described by Niesel and Thorhann [2]. The occurrence of the $\alpha_m$ polymorph has not been confirmed [3]. Further examination by DTA, XRD and high-temperature microscopy showed the influence of the thermal treatment temperature and the rate of cooling on the rate of the polymorphic transition $\beta \rightarrow \gamma$-Ca$_2$SiO$_4$, as well as on the phase composition of the sample. It was clearly seen in the DTA curves that lowering of the heating temperature reduced the $\beta \rightarrow \gamma$ transition peak area and altered the peak profile. The samples heated at 1450° gave only the $\gamma$-Ca$_2$SiO$_4$ phase after subsequent cooling. Lowering of the heating temperature to 1400° resulted in a 17% $\beta$ phase content after cooling.
Fig. 1 SEM micrograph of $\gamma$-Ca$_2$SiO$_4$ sample. Magnification 500 x

Fig. 2 DTA curve of Ca$_2$SiO$_4$ sample heated at 1500 °C. Heating: 795 °C, 1184 °C, 1443 °C. Cooling: 1442 °C, 1180 °C, 680 °C, 552 °C

J. Thermal Anal. 32, 1987