ABSTRACT

CSÁKI, Štefan: Thermophysical and electrical properties of illite-based ceramics. [Doctoral thesis]. Constantine the Philosopher University in Nitra. Faculty of Natural Sciences. Charles University. Faculty of Mathematics and Physics. Supervisor: prof. RNDr. Libor Vozár, CSc. (Constantine the Philosopher University in Nitra), doc. Ing. Patrik Dobroň, PhD. (Charles University). Nitra & Prague, 2018. 107 p.

Illitic clays are of special importance in the ceramic industry. Therefore, a deep knowledge of the thermophysical processes, as well as the electric properties, is of special importance. The illitic clay originated in Northeastern Hungary was used in this thesis. The reactions, occurring during firing, were studied using thermal analyses (Differential thermal analysis, Thermogravimetry, Thermodilatometry) and special attention was paid to the measurement of the electrical conductivity (both DC and AC). Up to 250 °C, where the removal of the physically bond water (PBW) takes place, the dominant charge carriers were the H^+ and OH^- ions. After the PBW was removed, Na^+ and K^+ ions became the dominant charge carriers. During dehydroxylation (450 – 750 °C) H^+ and OH^- ions were freed from the illite structure, which supported the electrical conduction in the samples. At ~ 970 °C glassy phase appeared and continuous conduction pathways were created. The frequency dependence of the AC conductivity revealed that ion hopping is the dominant conduction mechanism. The AC conductivity of the mixtures of the illitic clay with two types of oil shale ash (from pulverized firing and circulating fluidized bed combustion, 40 wt.% of ash content) up to 750 °C was influenced by the PBW removal, portlandite decomposition, and illite dehydroxylation. The dominant charge-carrying ions were the H^+ and OH^-. After the $CaCO_3$ decomposition at ~830 °C, Ca^{2+} ions became the dominant charge carriers. Mixtures of the illitic clay with 25 wt.% of calcite allowed studying the anorthite crystallization process using AC conductivity. The correlated motion of the ions during the crystallization lowered the contribution of the charge carrying ions to the AC conductivity. Therefore, the increase in the AC conductivity was decelerated. The results can be used for optimization the firing regime, as well as for the development of a sintering process assisted by an electric field (flash sintering).