Thermochimica Acta, 93 (1985) 521-524
Elsevier Science Publishers B.V., Amsterdam

THERMAL INVESTIGATIONS OF PYROPHYLLITES

Joachim Schomburg, VEB Kombinat Fliesen und Sanitärkeramik Boizenburg/Elbe, GDR

ABSTRACT

The results of DTA-, TG- and dilatometrical studies were reported. The content of adsorbed water is lower than 0.5 %. A sample expansion of 1 % can be obtained up to the beginning of the dehydroxylation at 450° C. During the dehydroxylation (450 - 800° C) a further expansion goes on. The dehydroxylated phase ("metapyrophyllite") is stable up to 1150° C. Crystalline high temperature phases are mullite and cristobalite. Pyrophyllite shows the typical thermal decomposition sequence for dioctahedral clay minerals: natural sample ⟶ homogeneous medium product (dehydrated) ⟶ homogeneous medium product (dehydroxylated) ⟶ heterogeneous reaction products.

INTRODUCTION

Pyrophyllite as a plate-shaped dioctahedral layer silicate is characterized by the absence of isomorphic compensation within the tetrahedral and octahedral sheets. The total layer charge has an amount of less than 0.1 perhalf elementary cell. For that reason, contrary to the other dioctahedral three layer silicates, no intercalation of interlayer cations is known. From the genetical point of view pyrophyllites can be found in low-hydrothermal veins and sometimes in large amounts in metamorphic schists. Pyrophyllites are used as raw material in the ceramic industry and as fillers for paper, paints and rubber. The thermal investigations were done to get informations about the technological behaviour of pyrophyllite by thermal treatment.

Proceedings of ICTA 85, Bratislava

MEASURING METHODS

The following samples were studied:

- pyrophyllite, Shokozan, Japan
- pyrophyllite, Robbins, N.-Carol., USA (ca. 15 % quartz).

The investigations were done with derivatographs using the combinations of the DTA - TG- and DTA - TD-methods. The sample material was crushed to a grain size less than 63 µm and studied up to 1100° C. The equipment conditions are comprehensive described in the literature (1).

RESULTS AND DISCUSSION

Both samples are characterized by a small content of adsorbed water. The weight loss up to 300° C is less than 0.5 %. A continuous expansion of the samples can be obtained up to the beginning of dehydroxylation (Fig. 1). The expansion of the pyrophyllite samples at this point (450° C) has an amount of 1 %. The delivery of 5 % hydroxyl water leads to a further expansion up to the end of the dehydroxylation process. This process is finished approximately at 800° C as it is to be seen from the DTG-curves. The temperatures of the DTA peaks for the dehydroxylation are for the samples from Robbins 690° C and for the sample from Shokozan 670° C. They confirm the known temperature interval for the dehydroxylation which is described in the standard literature for DTA - datas on minerals (2; 3; 4, 5; 6).

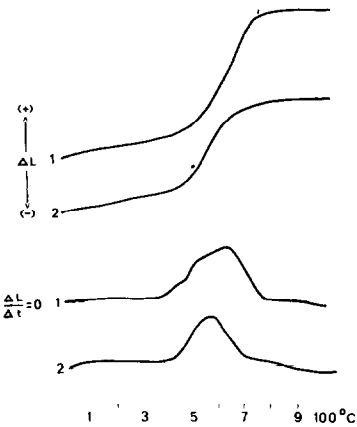

Fig. 1 TD- and DTD-curves of the pyrophyllites from Robbins (1) and Shokozan (2)

The following decomposition rates during the dehydroxylation of the sample from Shokozan were calculated from the TG-curve:

450 - 500° C - 5.2 %
500 - 600° C - 26.3 %
600 - 700° C - 44.7 %
700 - 800° C - 23.8 %

According to the investigations of Brindley (7) the dehydroxylated phase is stable up to 1150° C. The dilatometrical curves show a very small shrinkage for the temperature interval of the "metapyrophyllite" existence.
Above 1150° C mullite, cristobalite and amorphous silica were found as high temperature reaction products. The thermal decomposition process of pyrophyllites can be represented finally in the following way:

untreated pyrophyllite $\xrightarrow[H_2O]{\text{dehydratation}}$ homogeneous medium product (dehydrated pyrophyllite)

$\xrightarrow[H_2O]{\text{dehydroxylation}}$ homogeneous medium product ("metapyrophyllite")

$\xrightarrow{\text{complete structure decomposition}}$ heterogeneous reaction product (mullite, cristobalite, amorphous silica)

REFERENCES

(1) J. Schomburg & M. Störr, Thermochim. Acta 25 (1978), 313
(2) SCIFAX - DTA-data index, Cleaver Hume Press, London 1962
(3) V.P. Ivanova; Zapiski vses. miner. obsc. 90 (1961), 50
(4) A. Langier-Kuzniarowa; Termogramy ilastych mineralow. Wydawn. Geologiczne, Warszawa 1967
(5) N.H. Brett; K.J.D. Mackenzie & J.H. Sharp, Quart. Rev. 24 (1970), 185
(6) W. Smykatz-Kloss, Differential thermal analysis. - Berlin/Heidelberg/New York, Springer-Verl. 1974
(7) G.W. Brindley; Proc. Intern. Clay Conf. Mexico (1975), 119