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ISSN 0543-5846
METABK 47(1) 29-31 (2008)
UDK – UDC 622.354:666.31:666.85=111

THE THERMOPHYSICAL PROPERTIES OF SERPENTINITE

Received – prispjelo: 2006-11-13
Accepted – prihvaćeno: 2007-05-28
Original Scientific Paper – Izvorni znanstveni rad

In this article serpentinite from Banovina, Croatia, was studied. The antigorite is main mineral constituent of that rock. The dilatation curve shows that the first contraction of sample is coursed by dehydratation of antigorite at nearly 660 °C. In spite of this, the second contraction of sample, which begines at nearly 860 °C, is incident with olivine phase formation. The morphology of the serpentinite before and after thermal treatment was observed with the optical microscope. Image of serpentinite before thermal treatment is characterized by inclusions of olivine as primary mineral left as residue in process of serpentinization. Image of serpentinite after thermal treatment was changed by water disappear. The first thermal treated and than milled serpentinite has better properties than the first milled and than thermally treated serpentinite.

Key words: serpentinite, termophysical properties, ceramics materials, magnesia

Termofizička svojstva serpentinita. U ovom radu istraživan je serpentinit s nalazišta na Banovini u Hrvatskoj. U toj mineralnoj sirovini prevladavajući mineral je antigorit. Dilatacijska krivulja ukazuje da je prva kontrakcija uzorka uzrokovana dehidratacijom antigorita na približno 660 °C. Nasuprot tome, na drugu kontrakciju uzorka koja počinje pri približno 860 °C utječe stvaranje olivina. Morfologija serpentinita prije i poslije termičke obradbe promatrana je optičkim mikroskopom. Izgled serpentinita prije termičke obradbe karakteriziran je uključcima olivina kao primarnog minerala zaostalog u procesu serpentinizacije. Izgled serpentinita poslije termičke obradbe promijenio se uslijed eliminacije vode. Prvo termički obrađen te potom mljeven serpentinit ima bolje karakteristike od prvo mljevenog, a potom termički obrađenog serpentinita.

Ključne riječi: serpentinit, termofizička svojstva, keramički materijali, magnezijev oksid

INTRODUCTION

Serpentinite is ultrabasic rock. The serpentine group minerals, $Mg_3Si_2O_5(OH)_4$, is main constituents of serpentinites, are widespread and occur as alteration products of olivine and other magnesium-rich silicates. Serpentine minerals are found in metamorphic and in igneous rocks [1 - 3].

The serpentine group includes three closely related minerals: lizardite $Mg_3[Si_2O_5](OH)_4$, antigorite $(Mg,Fe)_3[Si_2O_5](OH)_4$ and chrysotile $Mg_3[Si_2O_5](OH)_4$, which have the same crystal structure and chemical composition, but their different curvature of the layers results in antigorite and lizardite being dense or fine-grained and crysotile being fibrous [4 - 8].

EXPERIMENTAL

The serpentinite investigated in this article is placed in Banovina area, Croatia. The serpentinite was characterized using X-ray diffraction (XRD) with CuK_{α} radiation. The Chirana Praha X-ray Diffractometer Model Mikrometa II type was used. Serpentinite was milled in Fritsch Pulverisette 502 ball mill with heatfield steel chamber.

Differential thermal analysis and thermogravimetrical analysis were conducted by derivatograph MOM Q 1500D at the heat speed of 10 °C/min in air atmosphere. The sample weight was 300 mg and the maximum temperature 1000 °C.

Optical microscope Neophot II type was also performed in order to observe the surface morphology of serpentinite bulk. In the dilatometry analysis was used Netzsch dilotometer 402E type.

RESULTS AND DISCUSSION

Results of XRD analysis are shown in Figure 1. XRD analysis indicates that antigorite is the main mineral constituent of Banovina serpentinite.

Figure 2. gives results of differential thermal analysis and thermogravimetrical analysis of serpentine before the thermal treatment. Thermal treatment of serpentinite was conducted at 660 °C during 3 hours. The

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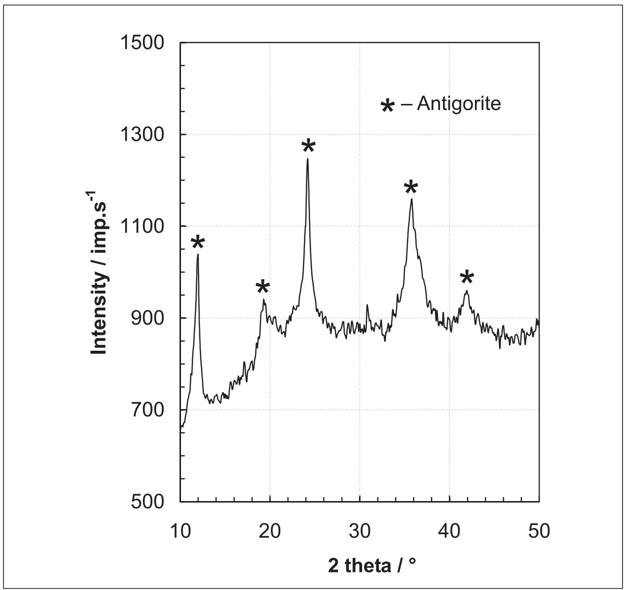

Figure 1. XRD analysis of Banovina serpentinite

endothermic peak at nearly 660 °C shows the decomposition of crystal structure of serpentine. The crystal lattice decomposition is related with 13 % weight lost course with disappearing of chemical bonded water. The beginning of forsterite formation is indicated by exothermic peak at 819 °C.

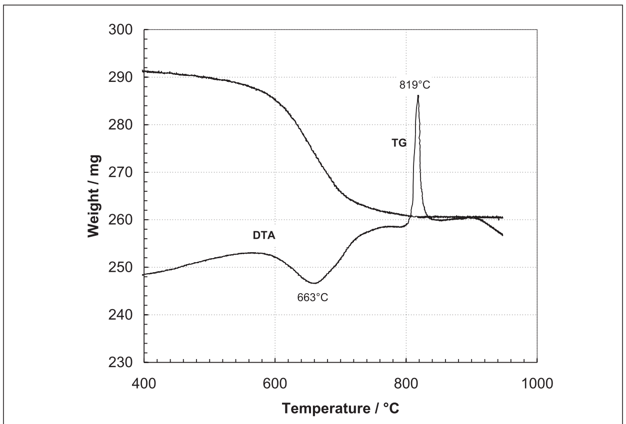

Figure 2. DTA and TG analysis of serpentine

The surface morphology of the serpentinite before and after thermal treatment was observed with the optical microscope. Figures 3. and 4. shows the photograph of the serpentinite before and after thermal treatment. Image before thermal treatment is characterized by inclusions of olivine as primary mineral left as residue in process of serpentinization. Image after thermal treatment was changed by water disappear. Creeps are appeared around the grains which does not contain water.

Figure 5. shows dilatation of serpentinite mineral raw material. The curve corresponding with DTA investigation indicate that the first contraction of sample is coursed by dehydratation of antigorite at nearly 660 °C and accompanied with olivine phase formation, which started at 660 °C. The second contraction of sample, which begines at nearly 860 °C, is incident with olivine

Figure 3. Photograph of serpentinite before thermal treatment at the magnification of 200 times

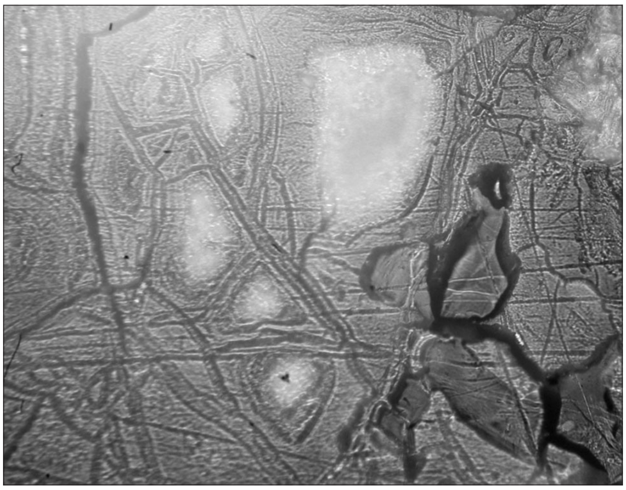

Figure 4. Photograph of serpentinite after thermal treatment at the magnification of 200 times

phase formation. The first contraction is 0,45 % and the second one is 9,17 %.

Figure 6. shows comparison of XRD analysis of two samples thermal treated serpentinite during 3 hours at 660 °C. The first one was first thermal treated and than milled and another was first milled and than thermal

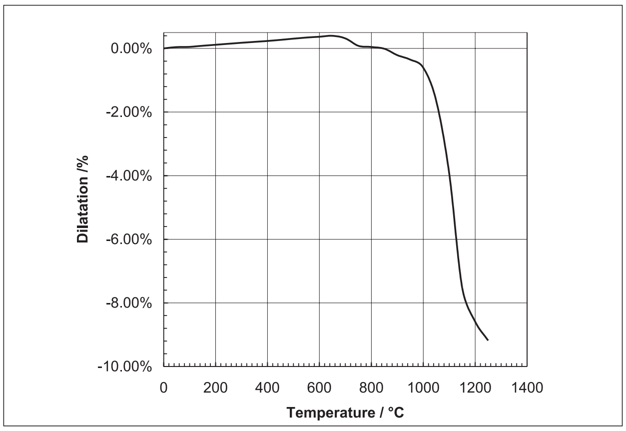

Figure 5. Dilatometry analysis of serpentinite

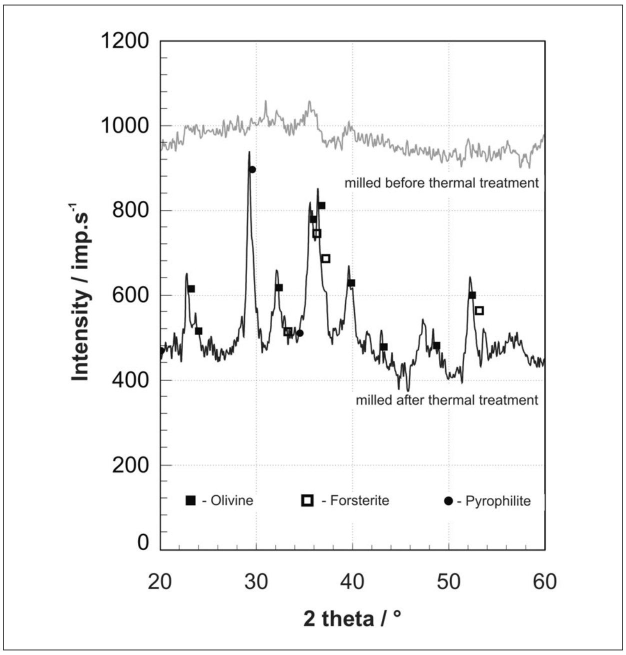

Figure 6. XRD analysis of thermal treated serpentinite

treated. It is clear that first thermal treated and than milled serpentinite has better properties.

CONCLUSIONS

The antigorite is main mineral constituent of Banovina serpentinite. The original crystal lattice of antigorite was destroyed by thermal treatment of serpentinite during 3 hours at 660 °C. The beginning of forsterite formation is at nearly 820 °C.

Image of surface before and after thermal treatment was observed with the optical microscope. Before thermal treatment serpentinite is characterized by inclusions of olivine as primary mineral left as residue in process of serpentinization. Image of serpentinite after thermal treatment was changed by water disappear.

The dilatation curve shows that dehydratation of antigorite at nearly 660 °C and beginning of olivine phase formation contraction is 0,45 %. The contraction of olivine phase formation is 9,17 %.

XRD analysis indicates that the thermal treatment of bulk serpentinite conducted at 660 °C during 3 hours, followed by milling gives better properties than first milling followed by thermal treatment of serpentinite on same conditions because olivine and forsterite formation is clear noted.

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Note: Autor is responsible as the language lecturer for English language.