THE CLAY SANDSTONE "VINISHTE" A POTENTIAL RAW MATERIAL FOR WHITE CERAMIC BODIES

Stoyan Djambazov, Albena Yoleva, Pavel Markov

University of Chemical Technology and Metallurgy
Sofia, BULGARIA, djam@uctm.edu

1. INTRODUCTION

The search for and investigation of new natural universal raw materials for the ceramic industry are always topical matters. The wide consumption of ceramic products and the introduction of new product technologies make it necessary to study new non-standard raw materials.

The aim of the present work is to make full characterization of a new natural clay raw material, called the clay sandstone "Vinishte" from the region of Montana, in Northwest Bulgaria.

2. EXPERIMENTAL

Plastic moulding has been used to prepare samples from the clay sandstone "Vinishte". The physico-mechanical properties of the clay sandstone "Vinishte" in the green state and after firing at 900, 1000 and 1100^{o}C by standard methods have been determined. Wet separation was also performed of the clay sandstone "Vinishte".

Three fractions were obtained with the following content: 1/ Sandy fraction – from 1 mm to 0,063 mm – 64,90 %; 2/ Clay fraction – from 0,063 mm to 0,001 mm - 22,00%; 3/ fine fraction – under 0,001 mm – 13,10 %. The chemical and mineralogical composition of the raw material and the fractions were determined by chemical analysis, X-ray diffraction analysis (diffractometer DRON 3M – Russia, Co Kα radiation) and DTA, DTG and TG in the temperature range 20 - 800°C ("Stunton Redcroft" apparatus – UK). Their phase composition was established.

3. RESULTS AND DISCUSSION

The chemical compositions of the clay sandstone "Vinishte" and the fractions are shown in Table 1. The phase composition of the raw materials is shown in Figure 1. The identified non-plastic component in the raw materials was quartz. The clay minerals present were illite and kaolinite. The sandy fraction basically consisted of quartz sand with low Fe_2O_3 content (below 0,15%). The X-ray diffraction data of the clay fraction is presented on Figure 2. The clay fraction contained kaolinite and illite with high Al_2O_3 content and relatively low Fe_2O_3 content to 1,73%. The DTA curves confirmed the mineral composition established of the clay sandstone "Vinishte". In the DTA curve shown in Figure 3 two endothermal effects are observed, as a result of the separation of water from the clay sandstone.

Oxides	Al_2O_3	Fe_2O_3	MgO	CaO	TiO_2	Na_2O	K_2O	SiO_2	LS
Clay sandstone "Vinishte"	6,46	0,42	0,22	0,10	0,23	<0,02	0,72	89,52	1,96
Sandy fraction	1,12	0,15	0,05	0,04	0,07	<0,02	0,13	97,36	0,50
Clay fraction	24,56	1,73	0,82	0,40	0,52	0,02	2,80	60,67	7,87
Fine fraction	30,10	2,43	1,07	0,63	0,41	1,18	3,83	49,85	8,97

Table 1. Chemical compositions of the clay sandstone "Vinishte" and of the fractions.

Figure 1. XRD of the clay sandstone.

Figure 2. XRD of the clay fraction

Figure 3. DTA, DTG and TG of the clay sandstone "Vinishte

The results of the measured physico-mechanical properties: drying and firing shrinkage, plasticity, mechanical bending strength and water absorption are given in Table 2. The clay fraction is semi-acid, high-plastic with high mechanical bending strength in the green state and after firing at 1100°C – 30 MPa. The phase present in the clay sandstone after firing at 900 and 1000°C is quartz. By increasing the firing temperature, the clay minerals begin to decompose and a new phase, mullite, is formed. The X-ray data of the clay sandstone thermally treated at 900, 1000 and 1100°C are shown in Figure 4.

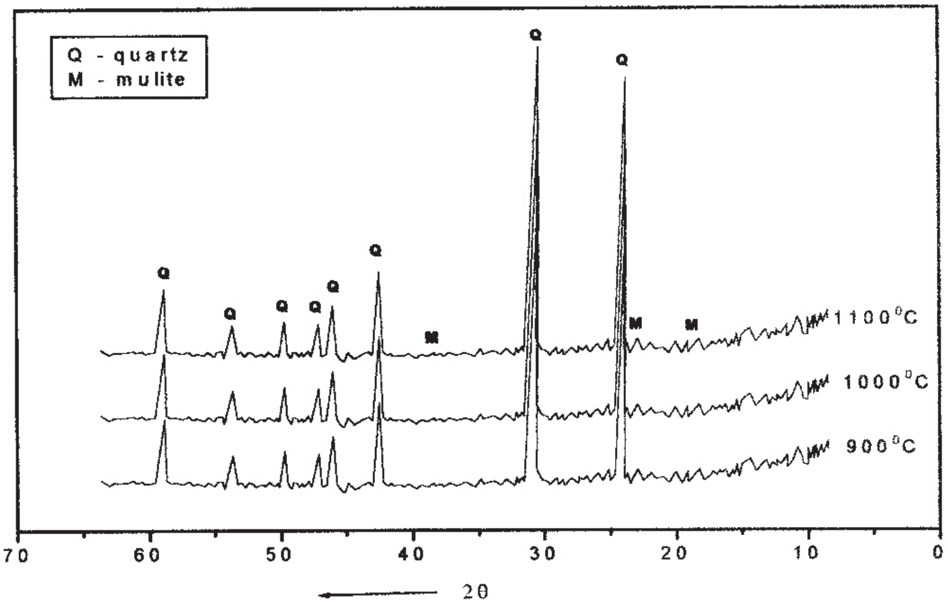

Figure 4. X-ray data of the clay sandstone thermally treated at 900, 1000 and 1100°C.

Properties			Clay sandstone "Vinishte"	Clay fraction
Moisture, %	relative		17,4	27,9
	absolute		21,6	38,8
Plasticity, %			17,4	28,5
Shrinkage, %	air		5	10
	firing	900°	2,16	1
		1000°	2,5	4,2
		1100°	3,7	5,7
Mechanical bending strength, %	green		2,3	5,5
	900°		3,8	20,8
	1000°		4,2	27,5
	1100°		4,4	30
Water absorption %	900°		17,4	20,15
	1000°		16,2	12,9
	1100°		15,5	6,3

Table 2. Physico-mechanical properties of the clay fraction.

4. CONCLUSIONS

In conclusion it may be noted that after fractioning the raw material by wet separation and floatation, two fractions can find application – a sandy fraction (consisting basically of quartz sand) and a clay fraction, presenting middle-plastic semi-acid clay with high mechanical bending strength in the green state and after firing. The low Fe_2O_3 content in the quartz sand (sandy fraction) can enable it to be successfully introduced in white ceramic body compositions for manufacturing different ceramic clinker products.