



Quarzwerke



Phase transformations of minerals during calcination of Bulgarian kaolin and obtaining products with a commercial application

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Kaolin EAD



- Established in 1924
- Company of Quarzwerke Gruppe since 2013
- The biggest producer of industrial minerals in South-Eastern Europe
- 2.8 million tonnes industrial mineral production per year

BULGARIA: Kaolin, Chamotte, Calcined Kaolin, Metakaolin, Silica Sand, Feldspar, Limestone, Dolomite, Ball Clay

SERBIA & UKRAINE: Silica Sand, Quartz, Ball Clay

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1. Brief Information about Kaolin

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Brief Information about Kaolin

- An industrial mineral belonging to the group of aluminosilicates
- Commonly known as China Clay as it was first discovered at Kao-Lin, in China
- Chemical formula; $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$
- Forms by alteration of anhydrous aluminium silicates in feldspar rich rocks by weathering or hydrothermal processes



1. Brief Information about Kaolin

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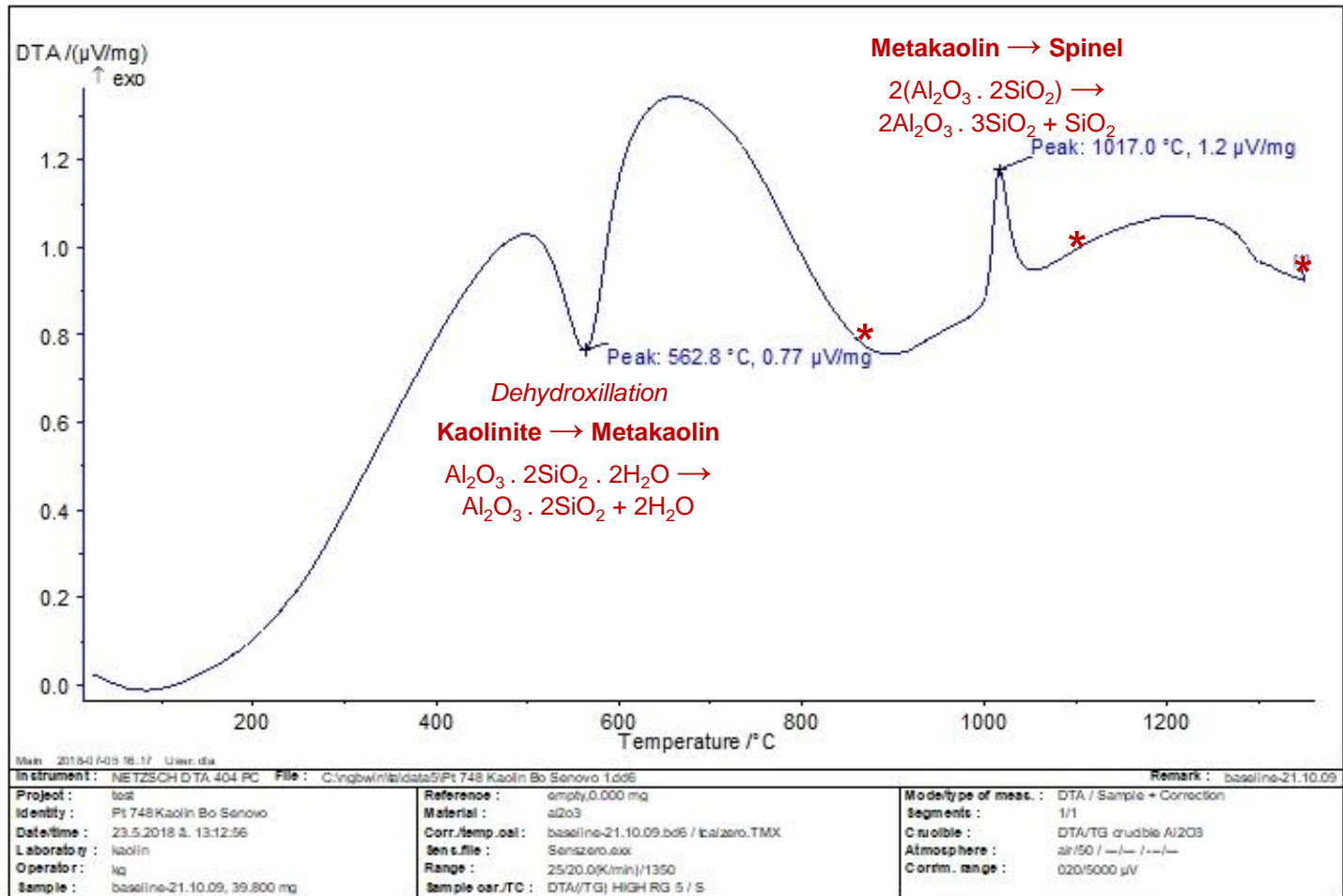
4. Application Areas of Obtained Products

Properties of Kaolin

Chemical Analysis	Kaolin
SiO ₂ , %	51.20
Al ₂ O ₃ , %	34.40
Fe ₂ O ₃ , %	0.64
TiO ₂ , %	0.18
CaO, %	0.15
MgO, %	0.22
K ₂ O, %	0.99
Na ₂ O, %	0.10
L.o.i, %	11.97

Mineralogical Analysis	Kaolin
Kaolinite, %	80
Quartz, %	10
Mica, %	8
Others, %	2

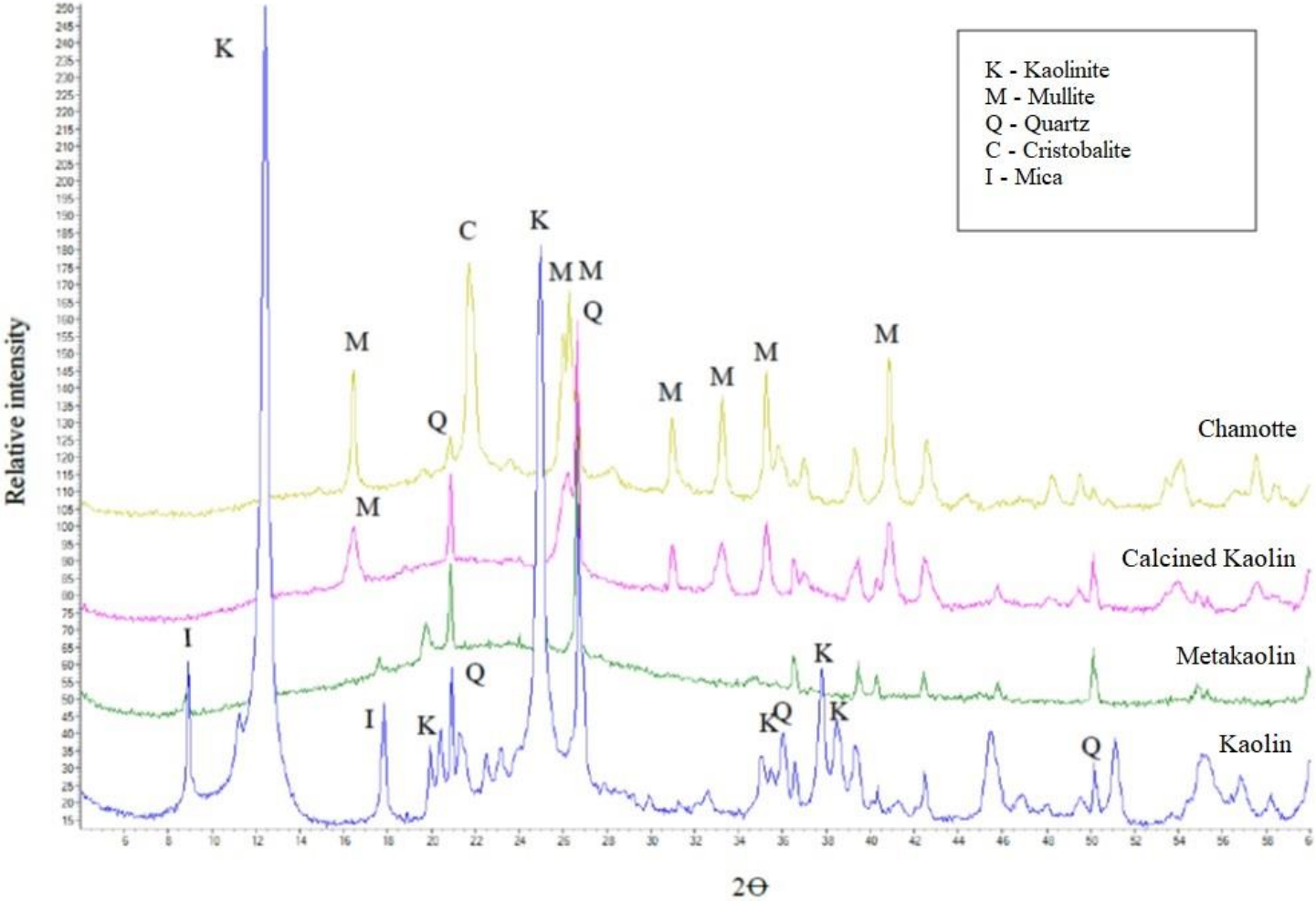
DTA



Chemical Analysis

	Kaolin	Metakaolin (~850 °C)	Calcined Kaolin (~1100 °C)	Chamotte (~1350 °C)
SiO ₂ , %	51.20	57.70	58.60	58.12
Al ₂ O ₃ , %	34.40	38.91	38.27	37.85
Fe ₂ O ₃ , %	0.64	0.73	0.77	1.05
TiO ₂ , %	0.18	0.20	0.22	0.31
CaO, %	0.15	0.16	0.22	0.28
MgO, %	0.22	0.23	0.28	0.30
K ₂ O, %	0.99	1.05	1.14	1.20
Na ₂ O, %	0.10	0.11	0.18	0.16
L.o.i, %	11.97	0.70	0.19	0.06

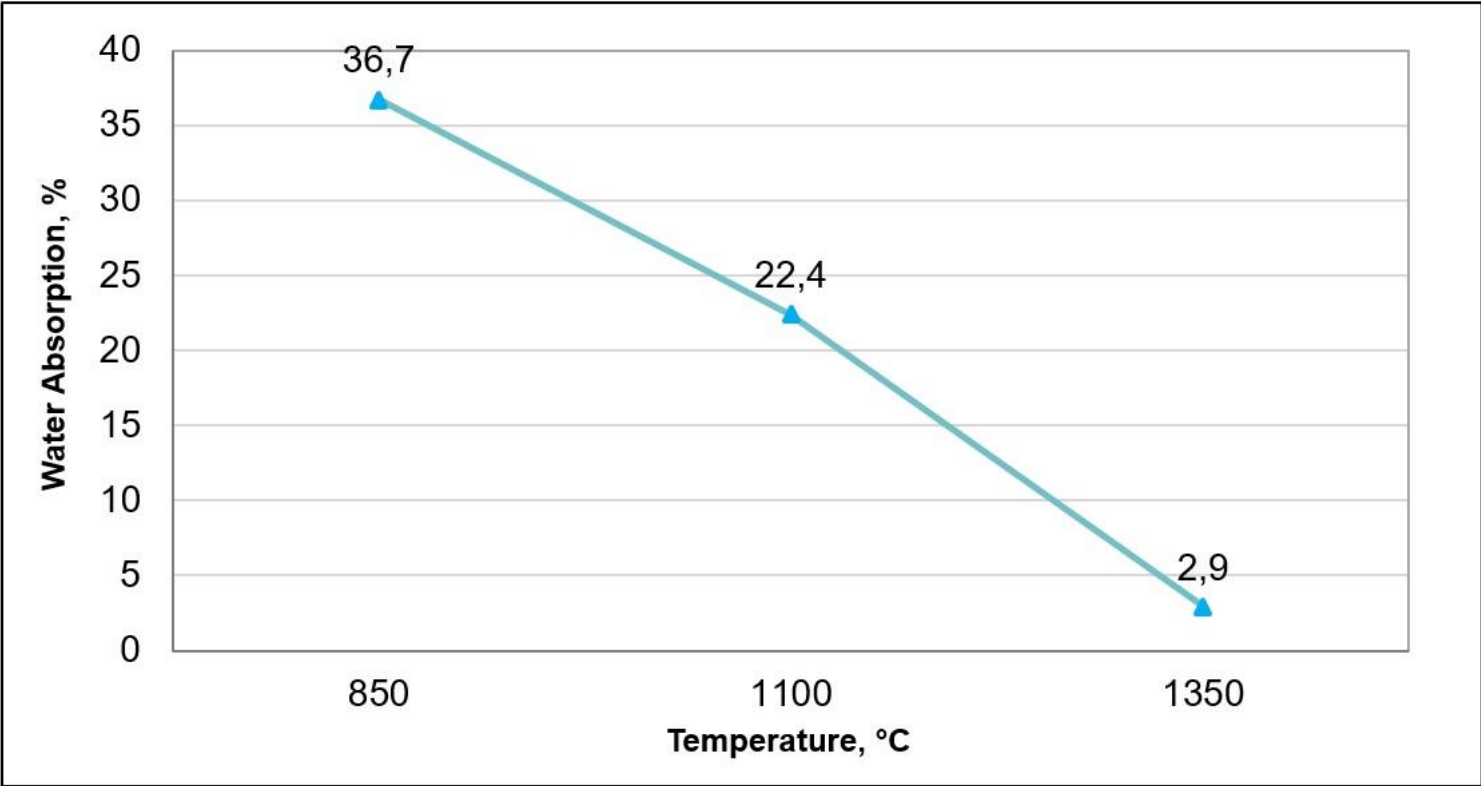
XRD Graph



Mineralogical Composition

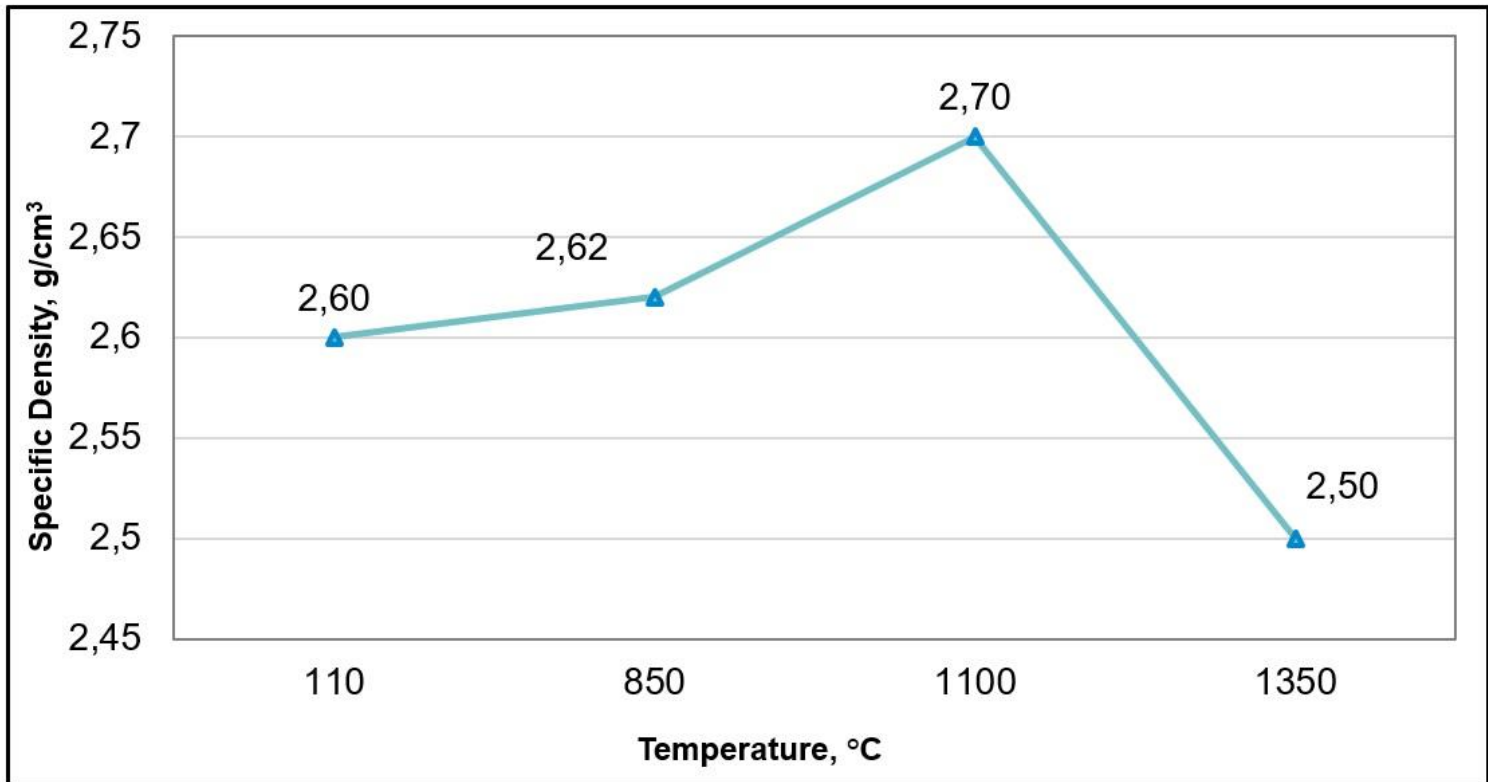
	Kaolin	Metakaolin (~850 °C)	Calcined Kaolin (~1100 °C)	Chamotte (~1350 °C)
Kaolinite, %	80	-	-	-
Quartz, %	10	10	10	5
Mica, %	8	4	-	-
Others, %	2	-	-	-
Mullite, %	-	-	20	36
Cristobalite, %	-	-	-	14
Amorphous Phase, %	-	86	70	45

Water Absorption



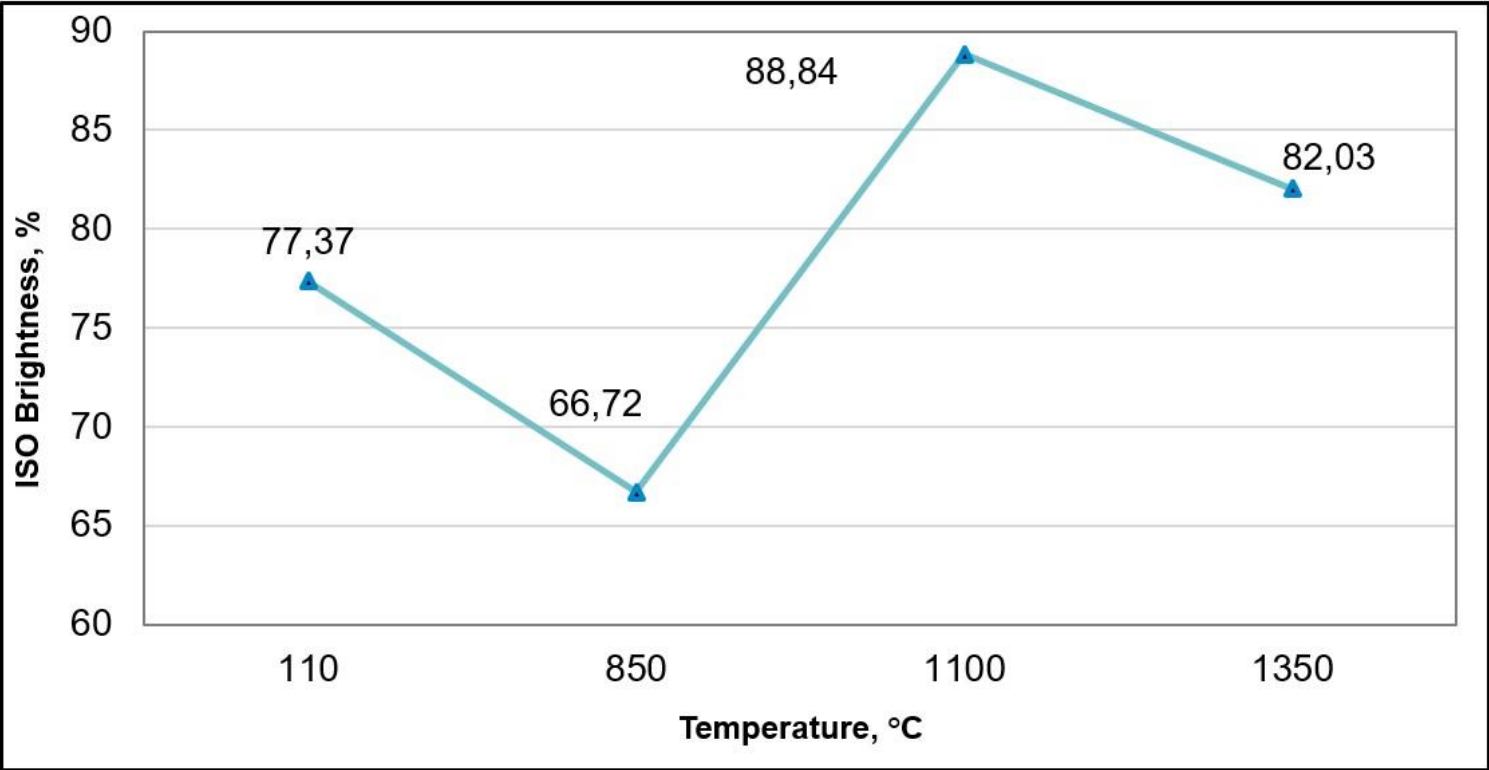
	Kaolin	Metakaolin (~850 °C)	Calcined Kaolin (~1100 °C)	Chamotte (~1350 °C)
Water Absorption, %		36.7	22.4	2.9

Specific Density



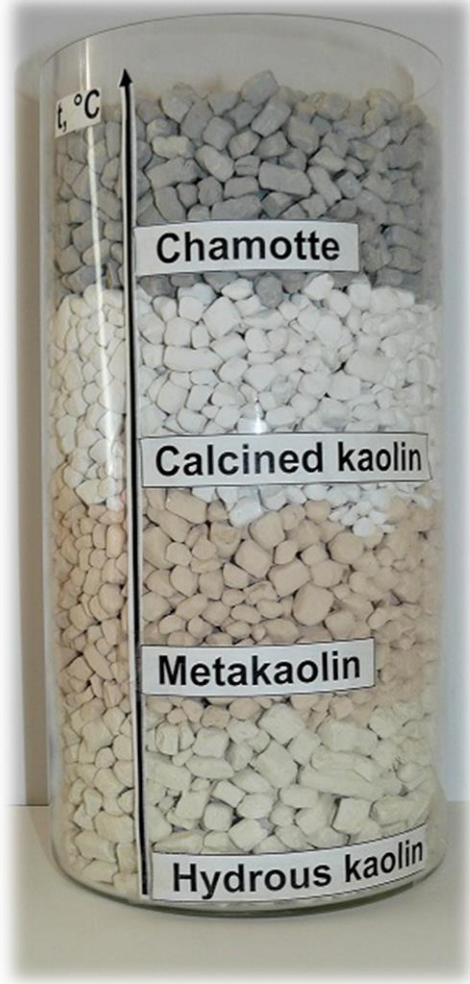
	Kaolin (110 °C)	Metakaolin (~850 °C)	Calcined Kaolin (~1100 °C)	Chamotte (~1350 °C)
Specific Density, g/cm ³	2.60	2.62	2.70	2.50

ISO Brightness



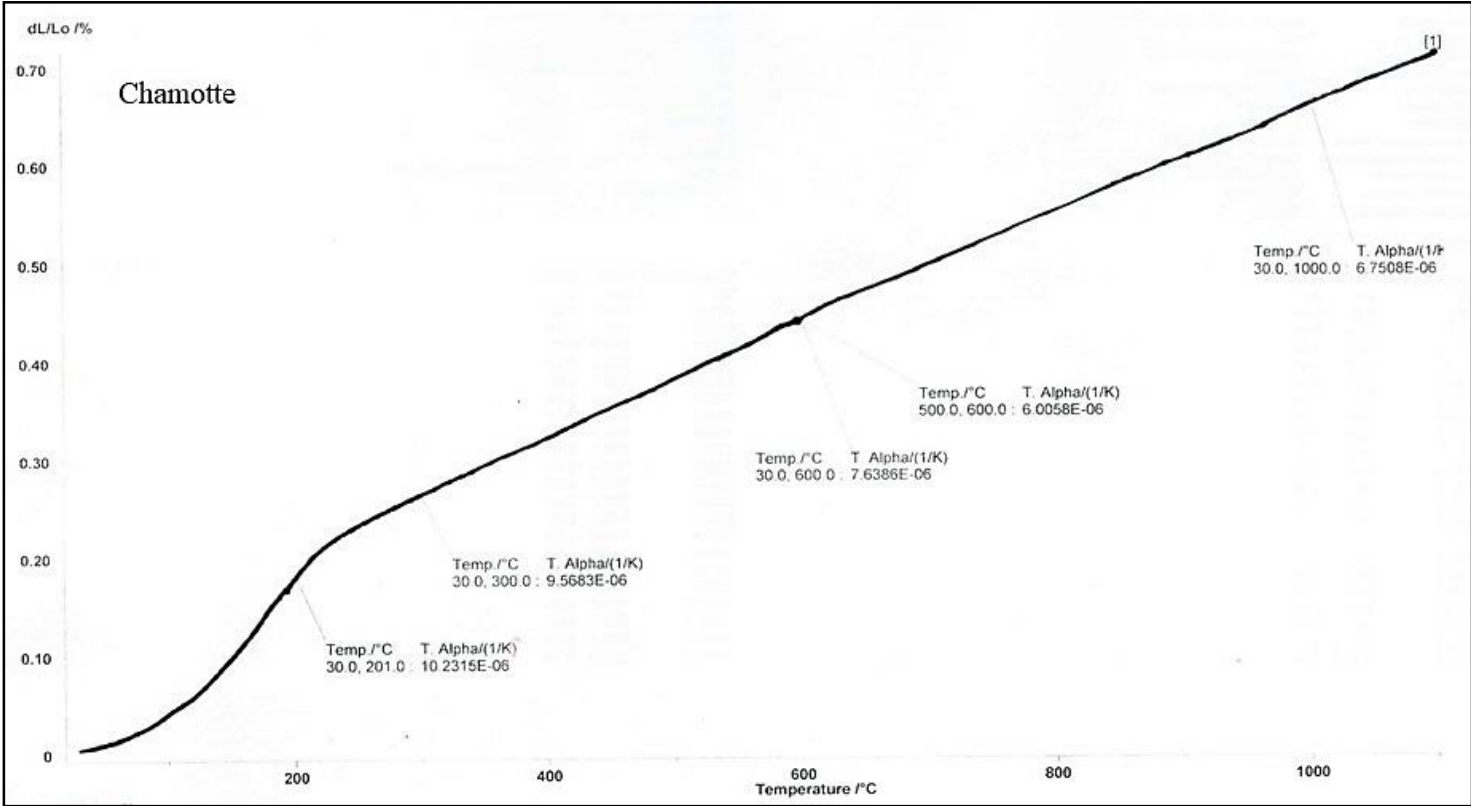
	Kaolin (110 °C)	Metakaolin (~850 °C)	Calcined Kaolin (~1100 °C)	Chamotte (~1350 °C)
ISO Brightness, %	77.37	66.72	88.84	82.03

Colour



	Kaolin	Metakaolin (~850 °C)	Calcined Kaolin (~1100 °C)	Chamotte (~1350 °C)
ISO Brightness, %	77.37	66.72	88.84	82.03
Yellowness, %	15.15	22.90	5.96	5.02
Lightness (L), %	94.86	90.90	97.16	93.99
a (+Red, -Green)	0.19	4.74	0.23	-0.08
b (+Yellow, -Blue)	8.09	10.02	3.10	2.64

Thermal Expansion Coefficient



Temperature, °C	T.Alpha, 1/K ($\cdot 10^{-6}$)	COE, %
30 - 200	10.23	0.18
30 - 300	9.57	0.26
30 - 600	7.64	0.44
30 - 1000	6.75	0.66

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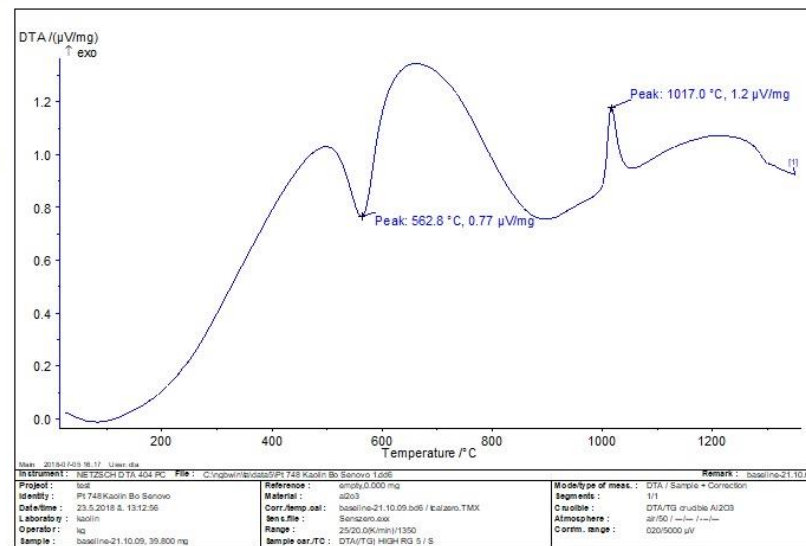
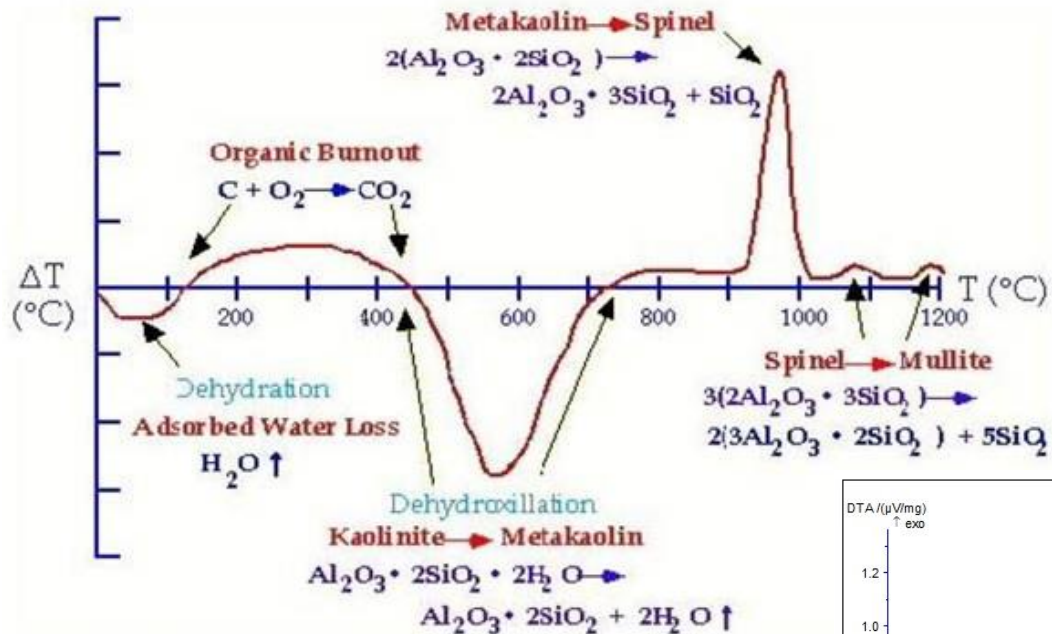
4. Application Areas of Obtained Products

Rotary Kiln

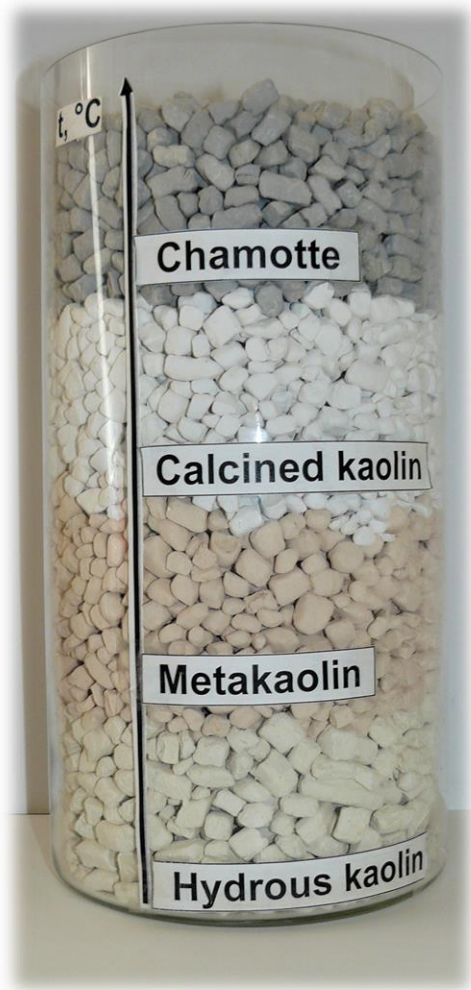


Rotary kiln in Vetovo-Bulgaria, 60 m long

Phase Transformations



Obtained Products



- **~850 °C** : Metakaolin CALK 85 UMB
- **~1100 °C** : Calcined Kaolin CALK 110
- **~1350 °C** : Chamotte CHK 36

Brief Information about Kaolin

Technical Study & Results

Calcination Process

Application Areas of Obtained Products

Chamotte

- **Ceramic Sanitaryware**

 - Reduces pyroplastic deformation during firing

 - Provides shrinkage control and controlled thermal expansion

- **Refractory**

 - Provides low thermal shock resistance and conductivity

 - Offers resistance to chemical attacks



Calcined Kaolin

➤ Ceramics

Partly replaces zircon and/or alumina in engobe and glaze compositions
Improve quality of glaze surface by reducing gas out during firing

➤ Paint & Coatings

Partly replaces TiO_2 and provides glossiness control

➤ Rubber Elastomers

Offers reinforcement
Improves mechanical and electrical properties



Calcined Kaolin

- **Plastics**

- Provides good optical properties in plastic compounds
 - Offers high impact strength in engineering plastics

- **Paper & Cardboard**

- Improves opacity, brightness, ink receptivity and printability

- **Ceramic Fiber**

- Provides chemical composition ready-to-melt in electrical arc furnace



Metakaolin

- **Geopolymer Tile**

Helps to produce tiles not by firing, but geopolymerization process

- **Cement, Concrete & Mortars**

Increases strength and durability

Reduces efflorescence of salts and increases resistance to chemicals

Provides lighter colours

- **Pigment**

Acts as an ingredient in production of Ultramarine Blue (*Sodium Polysulfide Aluminosilicate*)



Thank you !