New fine kaolin for white large slabs and glaze production

Ceramic tiles producers around the world are more demanding when it comes to glazes and engobes as well as super white bodies for tiles and large slabs. Imerys used its production process know-how and its deep understanding of the market trends to develop a new wet refined kaolin product, KaoShine BB30.

Imerys KBB kaolin product range

Imerys' site in Ukraine produces a full portfolio of kaolin, KBB range, for diverse industries such as tableware, sanitaryware, tile and white cement. The range main characteristic is its whiteness, achieved thanks to the careful selection of the secondary raw kaolin ore of the deposit.

In addition, Imerys' kaolin consistency has enabled its technical teams to fully control the chemical properties as well as the physical and mechanical characteristics of the various grades offered to the tiles and large slabs manufacturers.
When having a closer look at the kaolin chemical analysis (Tab 1.), the first characteristics are the high alumina and the low chromophore content which yields high whiteness. Consequently less zircon or whitener is needed to achieve the required whiteness, therefore reducing costs.
The second element to notice is the low level of contaminants which results in a decrease in glaze and body defects and an improvement of the user's quality yield. Other elements are the fine particle size, which positively impacts compaction and dry mechanical resistance in bodies, as well as rheology and suspension in glazes.

Kaolins for super white large slabs

With the current appetite from the end users for natural stone designs, such as marbles, the slab producers have the option to use very pure and white kaolin. However whiteness is not the only technical requirement that the body needs to fulfil.
According to specifications given by OEMs, the minimum requirements for large slab production are similar to conventional pressing bodies. In particular mechanical resistance before firing -measured in terms of green and dry MoR (Modulus of Rupture)- which must reach a minimum of 8 and 30 kg/cm² respectively.
However it turns out that additional features are needed to achieve the highest performances. Imerys focuses on four main characteristics for kaolins involved in super white slabs manufacturing:

- high pressability, i.e. good compaction and low expansion after pressing. As kaolin is used as the main plastic component, no other plastic mineral such as ball clay is added, except small amounts of bentonite and/or organic additives;
- enough "flexibility" and Modulus of Rupture to absorb the handling stresses on the production line before firing;
- good cleanliness to prevent colored spots appearing on very white body;
- high whiteness, thanks to low chromophores, Fe_2O_3 and TiO_2 mainly.

In the following study, seven kaolin products were selected from Imerys range -the most suitable ones for the targeted performance- and were benchmarked against a kaolin from another provider, used in the same applications and referenced as Kaolin B (Table 2). The composition presented in Table 3 was used to prepare the samples, at this stage of the study, no plasticizing additive was used.
Graph 1 shows that there is no close correlation between green MoR and deformation, best results being for KaoShine BB30 and BIP in terms of MoR and deformation respectively. After drying, the results are slightly different. Kaolins containing smectites have a high MoR but lower deformation which can be described as a more "brittle" behaviour. On the contrary, BIP is still showing higher deformation ability.

Imerys' KaoShine MO50 remains the best compromise of green and dry performance. When KaoShine BB30 is associated with smectite/illite bearing clays, the compaction and the resistance are improved for better dry performances. Firing was achieved in a fast firing lab electric kiln at various temperatures to compare the followings:

- fusibility - by measuring water absorption;
- densification - by measuring shrinkage and bulk density;
- whiteness.

KaoShine RC75 and KaoShine BB30 must be fired at slightly higher temperature to reach the full densification with low water absorption, which is due to their higher kaolinite content (Graph 2 and 3). The best whiteness results are obtained by KaoShine RC75 and KaoShine PL30, followed by Grolleg, BIP and KaoShine BB30. The high lightness value (Graph 3) combined with a low yellowness drive the exceptional whiteness of these kaolins.

As a conclusion, no single kaolin is able to offer the maximum of green, dry, and fired performances at the same time. From the above study, Imerys kaolins can achieve the optimum balance of properties, by using them in combination. High kaolinite content products like KaoShine BB30 can provide the best whiteness and be used in combination with KaoShine MO50 to obtain a white body with good pressability for instance.

White Kaolins for tiles glazes

KaoShine BB30 has also been developed to complement Imerys kaolin for the tiles glazes application. French kaolins Kaolinor 1C and Kerbrient are worldwide recognized for their characteristics and their valuable contribution to produce premium quality glazes on several aspects:

- no pin hole presence;
- high glossiness;
- smooth surface finish;
- good whiteness.

These performances are achieved thanks to a specific process designed by Imerys processing team. KaoShine BB30 benefits from Imerys long term experience in producing kaolins for tiles glazes which reflects in its characteristics and overall performances.
The fine Particle Size Distribution and the blocky shape of the kaolinite particles confer to the KaoShine BB30 enough suspensivity to be used in glaze and with a high fluidity.

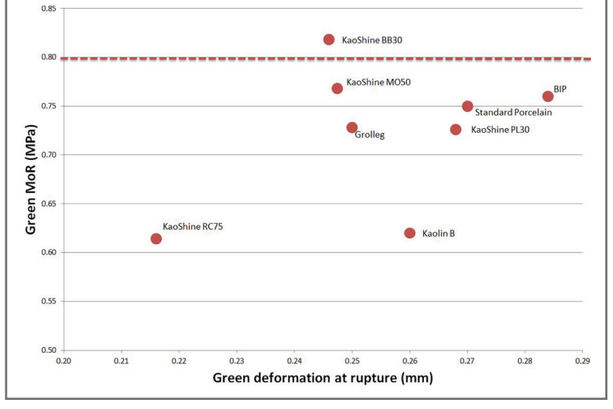
In addition the high purity of the kaolin leads to a low chromophore oxide and high alumina contents. This translates into a very white color development and a high quality surface of the glaze. KaoShine BB30 is therefore much appreciated in opaque and semi-opaque glazes.

Imerys' technical teams are continuously looking at ways to develop solutions to better meet manufacturers' needs based on current technology as well as meeting the demands of new technologies and production techniques coming into the market.

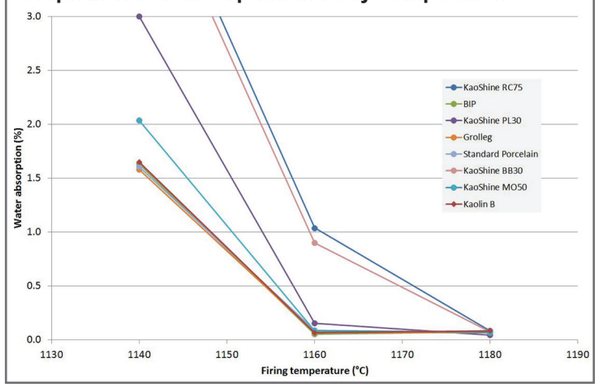
Table 1: Chemical Analysis

TYPICAL PROPERTIES CHEMICAL ANALYSIS (%)	Value
SiO_2	47.1
Al_2O_3	37.6
Fe_2O_3	0.35
TiO_2	0.56
K_2O	0.4
Na_2O	<0.1
CaO	0.4
MgO	<0.1
L.O.I.	13.4
PARTICLE SIZE ANALYSIS - Sedigraph (cumulative mass %)	
< 10 µm	95
< 5 µm	87
< 2 µm	70

Graph 1. Green MoR and deformation in body composition



Graph 2. Water absorption in body composition



Graph 3: Lightness L* vs. fired bulk density in body composition

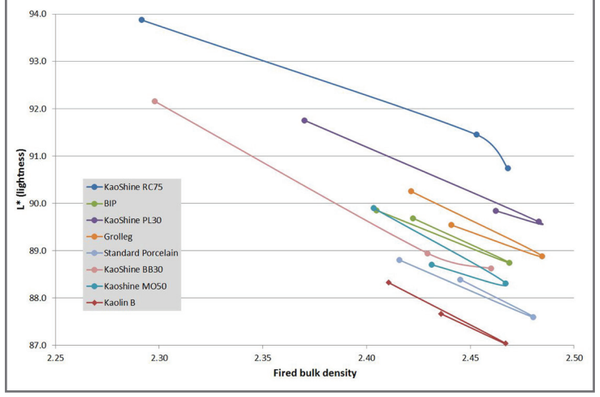


Table 2: Chemical analysis of the kaolins studied

Name	KaoShine BB30	KaoShine RC75	BIP	KaoShine PL30	Grolleg	Standard Porcelain	Kaoshine MO50	Kaolin B
Provider	Imerys	Imerys	Imerys	Imerys	Imerys	Imerys	Imerys	Other
Origin	Ukraine	Brazil	France	France	UK	UK	Brazil	
SiO_2	47.1	46.4	49.6	46.3	48.6	48.2	48.2	52.5
Al_2O_3	37.8	38.6	35.6	38	36	36.9	37.8	33.6
Fe2O3	0.3	0.57	0.4	0.43	0.83	0.71	0.65	0.7
TiO_2	0.6	0.67	0.01	0.33	0.04	0.04	0.67	0.43
CaO	0.17	0	0.11	0.05	0.07	0.1	0.12	0.13
MgO	0	0	0.04	0.05	0.17	0.3	0.08	0.39
Na_2O	0	0.06	0.06	0	0.06	0.07	0.02	0
K_2O	0.38	0.03	2.02	0.98	1.92	1.98	0.16	0.93
LOI	13.3	14.0	11.4	13.3	12.5	12.2	13.2	11.56
Quartz	2	0.5	6	2	1	1	4	11
Kaolinite	95	99	71	88	82	84	91	79
Muscovite	*		***	**	**	**	*	**
Mg, Ca Smectite			*		*	*	**	***
K feldspar					**	**		*
Anatase	tr	0.5					0.5	0.4
Rutile							0.2	tr

Table 3: Body composition to compare kaolins

	% (dry)
Floated feldspar	65
Silica sand	3
Kaolin	30
Zircon	2
Total	100
TPPS	0.4
Water	50
Milling time (min)	22
Pressing force (kg/ cm²)	450

Table 4: Kaolin for tiles glaze

		Kaolinor 1C	Kerbrient	KaoShine GL2	KaoShine BB30
Chemical analysis (mass %)	SiO_2	48	49.1	49.5	47.1
	Al_2O_3	36.9	35.9	35.5	37.8
	Fe_2O_3	0.8	0.85	1	0.3
	TiO_2	0.2	0.1	0.04	0.6
	K_2O	1.2	1.96	2.9	0.98
Particule size analysis	<2 µm	52	57	57	69

Table 5. Performances of Kaolin in tiles glaze formula

	Kaolinor 1C	Kerbrient	KaoShine GL2	KaoShine BB30
Surface aspect class	4	4	3	3
Whiteness class	3	2	3	4
Suspensitivity class	3	3	3	2

From 1 (acceptable) to 4 (excellent)