



SPECIALTY ALUMINAS FOR  
**TECHNICAL CERAMICS**

2018-2

# MARKETS & APPLICATIONS

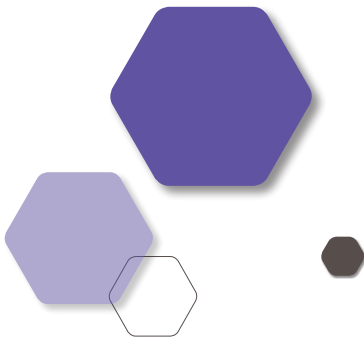
Alumina is one of the most important oxide materials for technical ceramics and is used in a wide range of applications. Finished parts offer high mechanical strength and hardness and resistance to both wear and chemical corrosion. Additionally, alumina ceramics exhibit very favourable thermal and electrical resistance properties, providing dimensional stability when heated and a good ability to dissipate heat.

The microstructure of alumina ceramics, and consequently their final properties, will depend essentially on:

- **Powder Preparation** which depends on the alumina characteristics (crystal size, powder particle size distribution, surface area, chemistry, additives, grinding)
- **Forming** which also depends on the process technique (for example pressing, slip casting, extrusion, injection moulding, tape casting)
- **Sintering** which depends on the method (temperature profile, atmosphere)

Applications often benefit from several ceramic properties and there is no standard classification between uses and function. This example of classification shows some applications that benefit from these characteristics:

Applications		AC34	AR3	P122	P662	P152	P162LS	P172LS
DENSE CERAMICS	<b>Structural ceramics</b> <ul style="list-style-type: none"> <li>• Ballistic protection</li> <li>• Rings, valves...</li> <li>• Bio ceramics</li> </ul>	●	●	●	●	●	●	●
	<b>Wear resistance ceramics</b> <ul style="list-style-type: none"> <li>• Grinding media, lining</li> <li>• Thread guides</li> <li>• Cutting tools</li> </ul>	●	●	●	●	●	●	
	<b>Thermal ceramics</b> <ul style="list-style-type: none"> <li>• HF chips package</li> <li>• Kiln furniture</li> </ul>	●						
	<b>Dielectrical ceramics</b> <ul style="list-style-type: none"> <li>• High-voltage insulators</li> <li>• Spark plugs</li> <li>• IC package</li> </ul>			●	●	●	●	●
	<b>Chemicals ceramics</b> <ul style="list-style-type: none"> <li>• Semiconductor industry</li> <li>• Solar panels</li> <li>• Medical &amp; food industry</li> </ul>	●	●	●	●	●	●	●
POROUS CERAMICS	<b>Catalyst support</b> <ul style="list-style-type: none"> <li>• Automotive exhaust catalysts</li> <li>• Particulate filters</li> <li>• Catalyst carriers</li> </ul>	●			●	●		
	<b>Filtration</b> <ul style="list-style-type: none"> <li>• Ceramic foam filters</li> <li>• Ultrafiltration membranes</li> </ul>	●						●



# ALUMINA FOR TECHNICAL CERAMICS

Besides chemical purity, the most critical parameter of alumina for ceramics is the size of its alpha crystals.

During the process of calcination, alumina hydrate first goes through several transitional phases, then  $\alpha$  alumina crystals appear and grow, while specific surface area decreases.

For unground calcined alumina, there is a relationship between specific surface area and  $\alpha$  crystal size.

ALTEO offers a continuous and tightly controlled range of crystal sizes for ceramists.

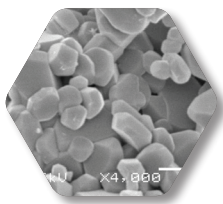
While most grinding operations do not reduce the alumina particle to its  $\alpha$  crystal size, alumina D50 is reduced towards the  $\alpha$  crystal size during grinding.

Alteo defines crystal size and ceramic properties of alumina with a special test known as "Reynolds test" or "R test":

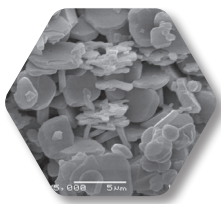
- **Milling conditions:** 125g of alumina for 4 kg of grinding balls (1 inch); 1,5 gallon jar; 4 hours at 70 rpm.
- **Crystal size:** D50 on Sedigraph after milling
- **Green density\*:** uniaxial pressing 4000 psi ( $\approx 28$  MPa)
- **Fired density\*:** heating rate: 22°C/min to 1000°C, 3.6°C/min from 1000 to 1670°C; Hold time: 1 hour at 1670°C; natural cooling.

Because of its low compaction pressure and fast sintering, the Reynolds Test is very sensitive to alumina properties. For the same reasons the values obtained for green density and fired density with the R test may be different from typical industrial values.

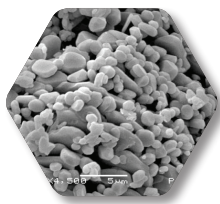
*\*Except P162LS & P172LS: pressing at 5000 psi ( $\approx 35$  MPa) and sintering at 1540°C, 2 hours.*



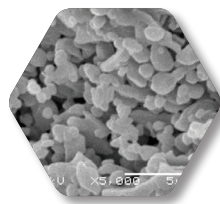
AC34



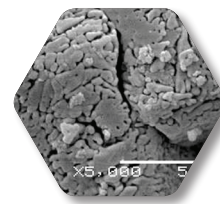
P122



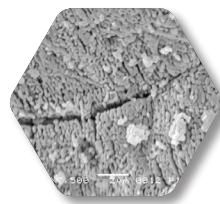
P662



P152

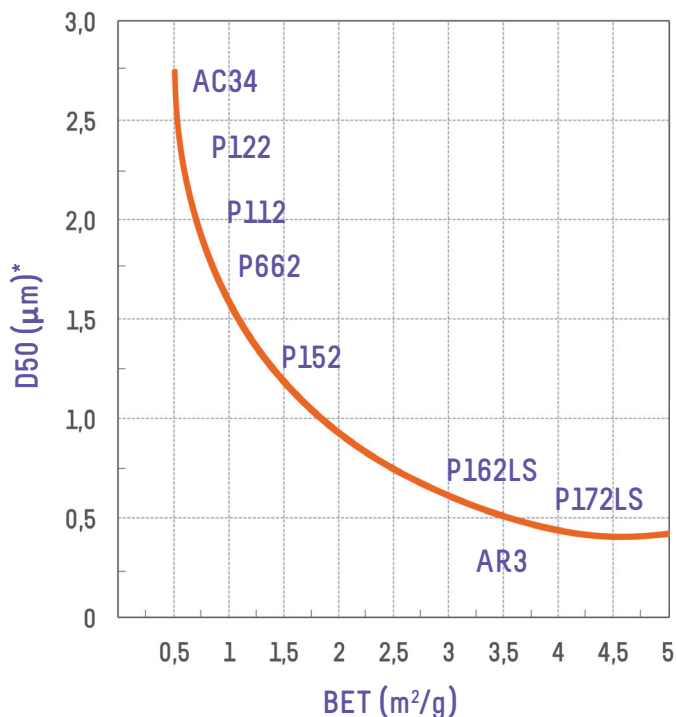


AR3

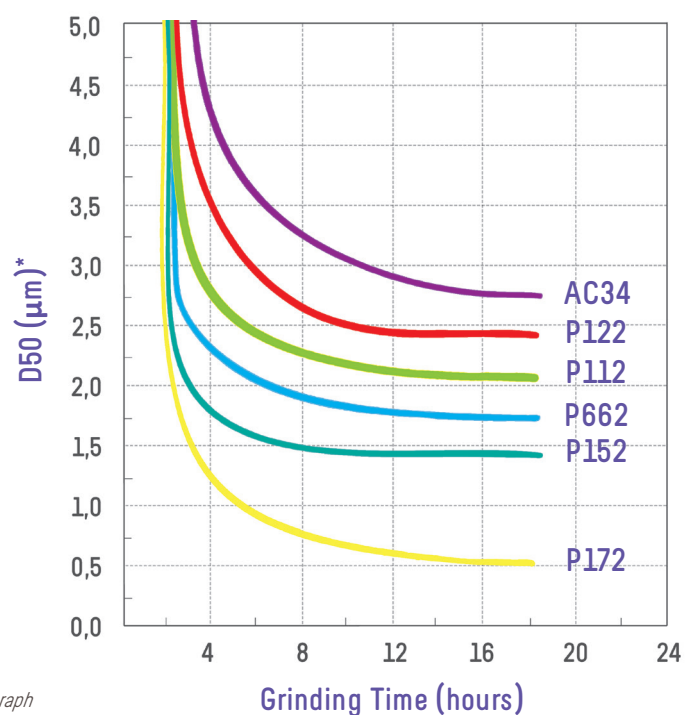


P172LS

## Unground Aluminas for Ceramics



## Alumina Dry Grinding



\*Sedigraph

# NORMAL SODA ALUMINAS

The tightly controlled calcination of **AC34** ensures the absence of under-calcined alumina, making AC34 usable in many applications. It also provides a wide and consistent crystal size distribution, making AC34 particularly suitable for body formulations where a low shrinkage is required. AC34 is available unground or ground (D50=3, 4, 5 or 6  $\mu\text{m}$ ) as a cost-effective solution for use in most structural ceramics.

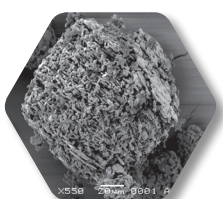
**ACBJ4C**, a jet milled normal soda alumina for a lower top-cut, has been designed with a narrow almost monomodal size distribution for porous ceramics.

**AR3**, a softer calcined grade, has a crystal size of 0.6  $\mu\text{m}$ , therefore it can be ground to various D50 for structural ceramics.

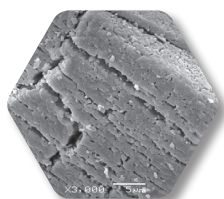


	Unit	Unground		Ground				
		AC34	AR3	AC34B3	AC34B4	AC34B5	AC34B6	ACBJ4C
<b>Physical properties</b>								
Specific Surface Area BET	$\text{m}^2/\text{g}$	0.55	3.6	1.2	1	0.9	0.8	0.7
Particle Size D50 laser (Cilas)	$\mu\text{m}$	75	85	3.5	4	5	6	5.5
<b>Chemical properties</b>								
$\text{Al}_2\text{O}_3$ on dry basis	%	99.7	99.7	99.7	99.7	99.7	99.7	99.7
$\text{Na}_2\text{O}$ total	ppm	2200	2200	2200	2200	2200	2200	2200
CaO	ppm	150	150	200	175	175	175	150
$\text{SiO}_2$	ppm	100	100	150	125	100	100	100
$\text{Fe}_2\text{O}_3$	ppm	120	120	150	150	150	150	150
<b>Ceramic Properties (R test)</b>								
Crystal Size D50 (Sedigraph)	$\mu\text{m}$	2.60	0.60					
Green Density	$\text{g}/\text{cm}^3$	2.31	2.15					
Fired Density	$\text{g}/\text{cm}^3$	3.40	3.50					
Linear Shrinkage	%	12.10	15.00					

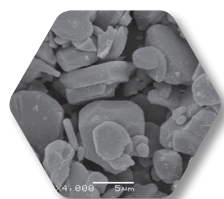
Typical data



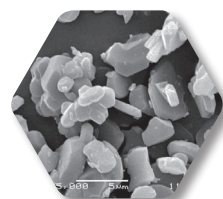
AC34



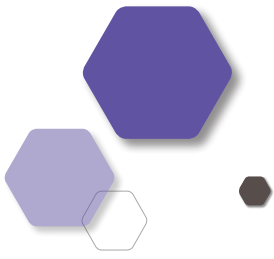
AR3



ACBJ4C



AC34B5



# LOW SODA ALUMINAS

The Reynolds proprietary process at the Gardanne plant is used to make very low soda content alumina, around 300 ppm, with primary crystal sizes ranging from 0.4 to 3 µm.

Alteo's aluminas allow ceramic manufacturers to optimise production cost, processability and desired final properties. These grades are suitable for ceramic body preparations from 90% (P122, P112, P662) to more than 99% alumina content (P152, P162LS, P172LS).

**P122 and P112**, with large crystals, are mainly used in spark plugs or low sodium structural ceramics where a low level of fine particles is needed.

**P662**, with round shaped crystals and a low surface area ensuring an easy processing, is used in a wide range of applications, from 90% to 98% alumina content.

**AMB** is a low-cost version of P662 designed for the grinding media industry and wear resistant alumina parts.

**P152**, with fine crystals but still reasonable surface area, is the best and industry leading alumina balance between processing and final properties. It can be used to produce 99.8% alumina ceramics with a fired density over 3.85 g/cm<sup>3</sup>.

**P172LS**, developed from the former P172 series, has a lower silica content and the finest alpha crystal on the market. Very high fired densities are achievable with **P172LS** at low sintering temperatures.

**P162LS** is Alteo's most recently developed alumina where a somewhat coarser crystal size is required;

Different versions of our alumina products are available or can be developed, don't hesitate to discuss your desired properties with us.

		Low Soda						
		AMB	P122	P112	P662	P152	P162LS	P172LS
<b>Physical properties</b>	<b>Unit</b>							
Specific Surface Area BET	m <sup>2</sup> /g	1.0	0.7	0.8	1.1	1.3	3,0	4.4
Particle Size D50 laser (Cilas)	µm	70	80	80	50	50	90	90
<b>Chemical properties</b>								
Al <sub>2</sub> O <sub>3</sub> on dry basis	%	99.80	99.85	99.85	99.85	99.85	99.90	99.90
Na <sub>2</sub> O total	ppm	400	350	350	300	300	350	500
CaO	ppm	350	150	150	200	550	150	150
SiO <sub>2</sub>	ppm	900	700	700	850	800	400	350
Fe <sub>2</sub> O <sub>3</sub>	ppm	175	130	130	130	130	200	150
<b>Ceramic Properties (R test)</b>								
Crystal Size D50 (Sedigraph)	µm	1.80	2.20	2.00	1.70	1.40	0.55	0.40
Green Density*	g/cm <sup>3</sup>	2.23	2.21	2.21	2.24	2.24	2.15	2.15
Fired Density**	g/cm <sup>3</sup>	3.30	3.20	3.25	3.45	3.82	3.85	3.90
Linear Shrinkage	%	12.3	11.6	12.1	13.4	16.3	17.7	18.0

\* Green density: uniaxial pressing @28MPa except P162LS-P172LS: 35MPa

\*\* Fired density: 1670°C /1h except P162LS-P172LS: 1540°C /2h. Measured after R-test

*Typical data*



# GROUND LOW SODA ALUMINAS

Our superground product range (SB series) is the ideal choice to achieve a high fired density associated with a homogeneous microstructure. These aluminas are batch dry ball-milled to or, very close to, the primary crystal size, ensuring the best compaction and sintering aptitude for a given calcined alumina.

**P122SB** can be used as-is in a wide range of formulations that require low soda levels.

P122 is also available jet milled at 6.5  $\mu\text{m}$ , as **P122B**.

**P152SB** is the most versatile product with a fine crystal and enhanced compaction aptitude. Easy to process, P152SB is able to exceed 3.85g/cm<sup>3</sup> fired density without any mineral flux.

**P662SB** has been developed as an intermediate between P122SB and P152SB.

**P172LSB** is the low silica version of P172SB and has a lower D50. Intensive grinding develops a population of very reactive particles which start to sinter at 1000°C. P172LSB ceramics can be fully densified from 1540°C. Magnesium oxide is added to constrain grain growth during sintering.

In case a slightly coarse crystal is desired, **P162LSB** is your better choice.

Do not hesitate to discuss with us your desired properties.

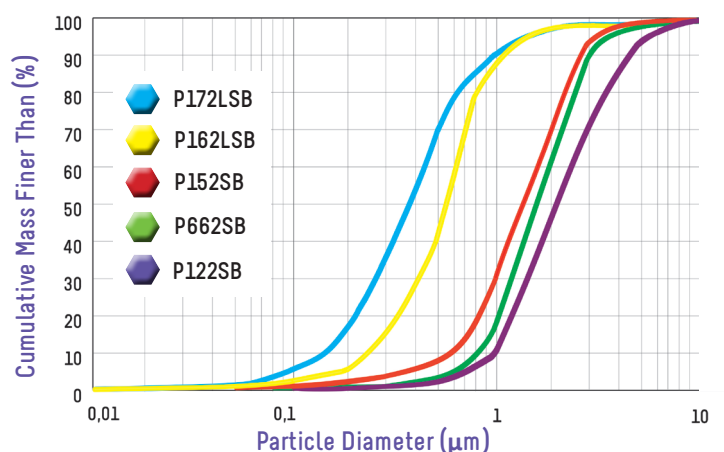
	Unit	Ground	Superground				
		P122B	P122SB	P662SB	P152SB	P162LSB	P172LSB
<b>Physical properties</b>							
Specific Surface Area BET	m <sup>2</sup> /g	1.0	1.8	2.0	2.6	6.0	8.0
Particle Size D50*	$\mu\text{m}$	5.50	2.30	1.70	1.40	0.55	0.40
<b>Chemical properties</b>							
Al <sub>2</sub> O <sub>3</sub> on dry basis	%	99.85	99.85	99.80	99.80	99.80	99.80
Na <sub>2</sub> O total	ppm	350	325	400	300	350	500
CaO	ppm	150	150	500	550	200	200
SiO <sub>2</sub>	ppm	700	800	900	800	450	325
Fe <sub>2</sub> O <sub>3</sub>	ppm	150	150	150	150	200	180
MgO	ppm					500	450
<b>Ceramic Properties (R test)</b>							
Crystal Size D50 (Sedigraph)	$\mu\text{m}$	2.10	2.10	1.50	1.35	0.55	0.40
Green Density**	g/cm <sup>3</sup>		2.21	2.23	2.25	2.15	2.15
Fired Density***	g/cm <sup>3</sup>		3.20	3.65	3.86	3.86	3.91
Linear Shrinkage	%		11.6	15.2	16.5	17.7	18.1

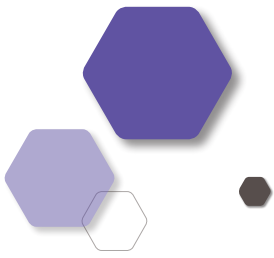
\*D50 is measured by sedimentation-Sedigraph on SB (Superground) products and laser-Cilas on B (ground) products.

\*\*Green density: uniaxial pressing @28MPa except P162LS-P172LS: 35MPa

\*\*\*Fired density: 1670°C / 1h except P162LS-P172LS: 1540°C / 2h.

*Typical data*





## P172HPB

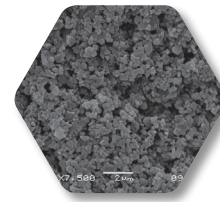
		P172HPB
Physical properties	Unit	
Specific Surface Area BET	m <sup>2</sup> /g	8.50
Particle Size D50 (Sedigraph)	μm	0.40
Chemical properties		
Al <sub>2</sub> O <sub>3</sub> on dry basis	%	99.90
Na <sub>2</sub> O total	ppm	80
CaO	ppm	130
SiO <sub>2</sub>	ppm	180
Fe <sub>2</sub> O <sub>3</sub>	ppm	150
MgO	ppm	500
Ceramic Properties (R test)		
Crystal Size D50	μm	0.40
Green Density (35MPa)	g/cm <sup>3</sup>	2.16
Fired Density (1540°C/2h)	g/cm <sup>3</sup>	3.93
Linear Shrinkage	%	18.1

Typical data

Al<sub>2</sub>O<sub>3</sub> content is given including added MgO

P172HPB is a further processed P172LSB, with an enhanced chemical purity. MgO is still required to control the grain size distribution after sintering, therefore mineral composition is around 99.9% Al<sub>2</sub>O<sub>3</sub>.

A higher fired density than P172LSB is achievable. Ceramics made with P172HPB have an exceptional bending strength and corrosion resistance at high temperature.



P172HPB

## P172SDP

### « READY TO PRESS » ALUMINA

		P172SDP
Physical properties	Unit	
Specific Surface Area BET	m <sup>2</sup> /g	8.0
Granulate Size D50	μm	125
Moisture	%	0.3
Loss On Ignition	%	2.1
Apparent Density	g/cm <sup>3</sup>	1.22
Chemical properties		
Al <sub>2</sub> O <sub>3</sub> on dry basis	%	99.8
Na <sub>2</sub> O total	ppm	500
CaO	ppm	200
SiO <sub>2</sub>	ppm	325
Fe <sub>2</sub> O <sub>3</sub>	ppm	180
MgO	ppm	450
Ceramic Properties (R test)		
Crystal Size D50	μm	0.40
Green Density (100MPa)	g/cm <sup>3</sup>	2.27
Fired Density (1540°C/2h)	g/cm <sup>3</sup>	3.91
Linear Shrinkage	%	16.6

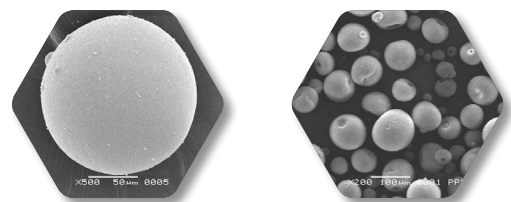
Typical data

Al<sub>2</sub>O<sub>3</sub> content is given including added MgO

P172SDP is a spray-dried P172LSB. This ready-to-press powder is recommended for high alumina content ceramics (99.8%). The reactivity of P172SDP permits high fired density (over 3.92) with a sintering temperature below 1600°C.

Standard P172SDP contains 2% of organic additives and is suitable for all types of forming processes. A second version of P172SDP, has 3% of additives in order to achieve a higher green mechanical strength. This version is therefore suitable when Isostatic Pressing (cold-CIP, hot-HIP) is followed by cutting and polishing of the green piece before firing.

P172SDP contains MgO to control final microstructure, no additional additives are required to process this alumina.



P172SDP

## ALTEO R&D

For Alteo, innovation and application R&D are major parts of its growth strategy.

Alteo enhances its R&D capabilities through its **application laboratory**: the installation of **state-of-the-art equipment**, the recruitment of **technical experts** and collaborations with key partners and **university laboratories**.

Alteo constantly strives for the **best specialty alumina-based solution to your ceramics ambitions**: our applications laboratory can study ceramic properties in porous and dense ceramic applications.

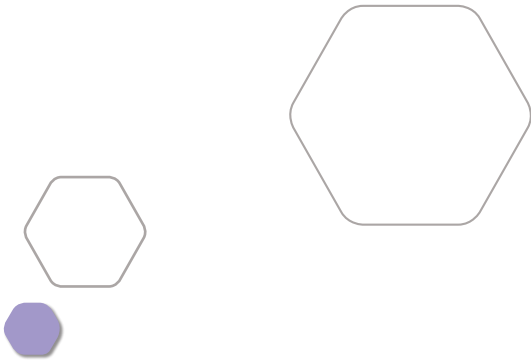
Alteo has the know-how and equipment to **analyze and evaluate raw materials and finished parts, as well as being able to simulate production processes**.

Contact our R&D team now at [www.alteo-alumina.com/contact](http://www.alteo-alumina.com/contact)

## CUSTOMER CARE COMMITMENT

To meet your highest expectations, our Customer Care team will always strive to ensure a **first class** service.

Our commitment is to provide **full support** from your first call to the delivery of our products; with technical assistance, packing solutions and short lead times.



[www.alteo-alumina.com](http://www.alteo-alumina.com)

### R&D CAPABILITIES



## ALTEO AT A GLANCE

- A world leading fully-integrated supplier of specialty aluminas with a capacity of more than 600 000 tonnes of alumina based products (hydrates and calcined aluminas).
- Global sales network with 4 regional hubs, 14 offices and local warehouses around the world.
- Development centre in France.
- Leading raw material supplier to the following industrial markets: Ceramics, Refractories, Specialty Glass, Polishing, Fillers and Coatings.