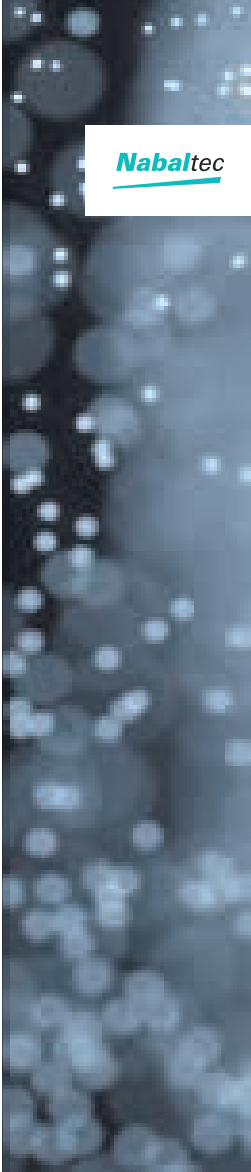
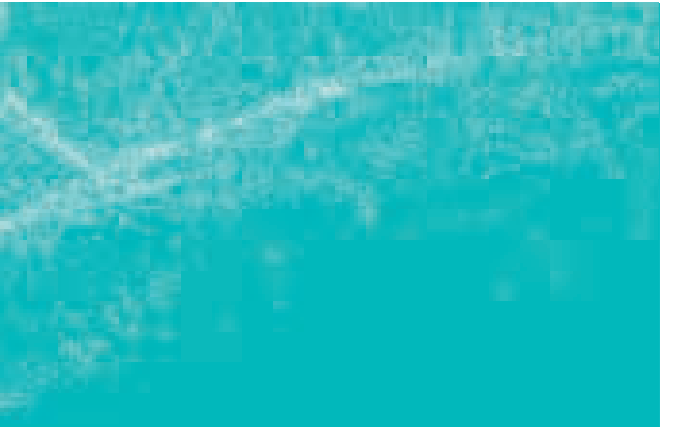
# Products





***Nabal**tec AG*

Our know-how for your safety

# Content

# Aluminium hydroxides
# APYRAL®

# Boehmites and additives
# ACTILOX®

# Aluminium hydroxide

Aluminium hydroxide, produced by the "BAYER-Process", is utilized by a number of different branches of industry.

| NH 20 | |
|---|---|
| Main applications: | Production of<br>• glass and ceramic products<br>• aluminium fluoride, Cryolite and other aluminium salts<br>• frits and pigments<br>• molecular sieves<br>• catalysts<br>• refractory products<br>• pigments |

| Average chemical analysis | Unit | |
|---|---|---|
| **$Al(OH)_3$** | [%] | 99.7 |
| **$SiO_2$** | [%] | 0.02 |
| **$Fe_2O_3$** | [%] | 0.02 |
| **$Na_2O$** | [%] | 0.2 |
| **Loss on ignition (105 - 1000 °C)** | [%] | 34.6 |
| **Moisture content (20 - 105 °C)** | [%] | 0.1 |
| **Properties** | | |
| **Bulk density** | [kg/m³] | 1000 - 2000 |
| **Specific density** | [g/cm³] | 2.4 |
| **Crystal structure** | | Gibbsite |

all values related to dried material

# APYRAL®

**APYRAL®** with the chemical formula $Al(OH)_3$, from ***Nabal**tec* is an environmentally friendly halogen free product which is used as a flame retardant filler in a wide variety of rubber and polymeric materials. During thermal decomposition **APYRAL®** does not generate toxic or corrosive gases. In addition, there is a distinct reduction in smoke density.

**APYRAL®** is effective in the crucial phase of the burning process before the outbreak of a fully developed fire.

**APYRAL® - the flame retardant filler, offers these advantages:**

- free of halogens
- environmentally friendly
- no development of toxic gases
- reduction of consequential damage
- clear reduction in smoke density
- cost effectiveness

***Nabal**tec* offers a wide range of **APYRAL®** products to cover the different requirements of the plastics processing industry. The **APYRAL®** types produced by different production processes can be distinguished by their properties into the five groups below:

1. Standard products
2. Morphology modified products
3. Ground products
4. Viscosity optimized products
5. Fine precipitated products.

The quantity of **APYRAL®** added to the organic matrix depends on the required flame retardancy, the properties of the end products and the cost of the mixture. **APYRAL®** can replace other more expensive flame retardants. In addition, the amount of the usually more expensive polymer can be reduced and replaced by the cost effective filler **APYRAL®**. As a result, the total cost of the compound is generally reduced and is therefore more financially favourable.

| | Unit | APYRAL® 1 - 44 | APYRAL® 40 - 120 |
|---|---|---|---|
| **$Al(OH)_3$** | [%] | 99.7 | 99.5 |
| **$Fe_2O_3$** | [%] | 0.01 | 0.01 |
| **$SiO_2$** | [%] | 0.01 | 0.01 |
| **$Na_2O$ total** | [%] | 0.2 | 0.4 |
| **Loss on ignition (105 - 1000 °C)** | [%] | 34.6 | |
| **Specific density** | [g/cm³] | 2.4 | |
| **Crystal structure** | | Gibbsite | |

# APYRAL® types

The following tables show characteristic values of the different **APYRAL®** products:

| Product | Grain size D50 [µm] | Grain size D90 [µm] | Specific surface BET [m²/g] | Bulk density [kg/m³] | Moisture [%] |
|---|---|---|---|---|---|
| **Standard product** | | | | | |
| **APYRAL® 1E** | 50 | 100 | 0.2 | 1000 | 0.05 |
| **Morphology modified** | | | | | |
| **APYRAL® 2E** | 20 | 50 | 0.5 | 950 | 0.1 |
| **Ground** | | | | | |
| **APYRAL® 8** | 15 | 30 | 1.3 | 750 | 0.1 |
| **APYRAL® 15** | 12 | 23 | 1.7 | 600 | 0.2 |
| **APYRAL® 16** | 16 | 44 | 1.8 | 750 | 0.1 |
| **APYRAL® 24** | 8 | 21 | 2.5 | 650 | 0.15 |
| **Viscosity optimized** | | | | | |
| **APYRAL® 20X / 20HC** | 8 | 80 | 1.2 | 550 | 0.1 |
| **APYRAL® 30X** | 7 | 45 | 1.5 | 500 | 0.1 |
| **APYRAL® 22** | 12 | 40 | 2.0 | 600 | 0.15 |
| **APYRAL® 33** | 6 | 20 | 3.0 | 550 | 0.15 |
| **APYRAL® 44** | 8 | 19 | 2.3 | 500 | 0.2 |
| **Fine precipitated** | | | | | |
| **APYRAL® 40CD** | 1.5 | 3.3 | 3.5 | 400 | 0.2 |
| **APYRAL® 60CD** | 1.0 | 2.4 | 6 | 300 | 0.3 |
| **APYRAL® 120E** | 0.9 | 2.9 | 11 | 200 | 0.5 |
| **APYRAL® 200SM** | 0.4 | 0.8 | 15 | 200 | 0.8 |

# APYRAL® applications

**APYRAL®** types can be used as a flame retardant filler in the following polymer materials:

- thermosets
- elastomers
- thermoplastics

**Typical applications are:**

- cable compounds
- technical rubber compounds
- pressed and cast plastic parts
- thermal insulation foams
- glass fiber reinforced plastics

| Application \ APYRAL® | 1E | 2E | 8 | 15 | 16 | 24 | 20X | 20HC | 30X | 22 | 33 | 44 | 40CD | 60CD | 120E | 200SM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carpet beddings** | • | | • | | • | | | | | | | | | | | |
| **PUR-foams** | | | | • | • | • | | | | | | | • | • | | |
| **SMC** | | | • | | • | | • | • | • | • | • | | • | • | | |
| **BMC** | | | • | • | | • | • | • | | | | | | | | |
| **Pultrusion** | | | | | | • | • | • | | | • | • | • | | | |
| **RTM** | | | | | | • | • | • | • | • | • | • | • | | | |
| **Hand lay up** | | | • | | • | • | • | • | • | • | • | | | | | |
| **Laminates** | | | • | | • | • | | | | | • | • | • | • | | |
| **Gelcoats** | | | | | | | | | | | | | • | • | | • |
| **Casting resins** | • | • | • | • | • | | • | • | • | • | • | • | • | | | |
| **Conveyer belts** | | | • | | • | | | | | | | | • | • | • | • |
| **Cable beddings** | | | • | • | • | | | | | | | | | | | |
| **Cable insulations** | | | | | | | | | | | | | • | • | | |
| **Cable jacketings** | | | | | | | | | | | | | • | • | • | • |
| **Membranes, Tarpaulins** | | | • | • | | | | | | | | | • | • | | |
| **Thermal insulations** | | | | | | | | | | | | | • | • | | |
| **Profiles, Pipes** | | | | | | | | | | | | | • | • | | |
| **Insulators** | | • | | | | | • | • | • | | | | • | • | | |
| **Dispersions** | • | • | • | • | | • | | | | | | | • | • | | |
| **Adhesives** | • | • | • | | | | | | | | | | • | • | | |
| **Coatings** | | | | • | | • | | | • | | | • | • | • | • | • |

# Boehmite:
# APYRAL® AOH and ACTILOX® B / SM

Based on a highly sophisticated process, ***Nabal****tec* is producing an aluminium oxide hydroxide (AlOOH), which has been introduced to the market under the trade names **APYRAL® AOH, ACTILOX® B** and **ACTILOX® SM**.

The excellent processing properties are a consequence of the special almost cubic structure of our Boehmite particles. As a result of this property, a good dispersion is readily achieved during processing of highly filled plastic compounds and in both water- and solvent-borne dispersions.

The high purity of **APYRAL® AOH, ACTILOX® B** and **ACTILOX® SM** allows it to be used in electrically insulated components and electronics. Since they exhibit a very high temperature resistance, up to 340 °C, they can also be used in temperature demanding applications. Above this temperature a slow degradation occurs under water release. Used as a halogen free mineral co-flame retardant, our Boehmites can partially substitute organic phosphorous flame retardants and contribute to significant cost savings in the compounds. This can be utilized in thermoplastic and thermoset compounds.

The difference between **ACTILOX® B** and **APYRAL® AOH** is characterized mainly by a even higher purity level of **APYRAL® AOH** which is necessary for PCB and LIBS applications but not for polymer applications, e.g. engineering plastics, epoxides, etc.

### For Lithium-ion batteries

Boehmite in separator film coating convinces by conveying high level of component reliability. This filler reduces the risk of short-circuiting in Lithium-ion batteries (LIBS) to a minimum and this in turn increases safety for the consumer.

### For electronics

In epoxy based printed circuit boards our highly pure Boehmite is used. It can replace the thermally instable aluminium hydroxide, therefore multiple reflow-soldering is possible without problems. In addition, it leads to a significant cost reduction for PCBs by also reducing the amount of necessary phosphorous flame retardants as well. Similar advantages are obtanable in Epoxy Moulding compounds, Epoxy Cast resins and substrates for semiconductors.

### For engineering plastics

In combination with phosphorous and nitrogen containing flame retardants. Boehmites have proven their high efficiency. They promote processing in extrusion or injection mold processes which improves the output rate or reduces cylce times of a production. Furthermore, the usage of Boehmite as inert flame retardants may actively reduce interfering acidic by-products of the flame retardants, stabilizing the polymer matrix positively.

| Average chemical analysis | Unit | APYRAL® AOH |
|---|---|---|
| **AlOOH-content** | [%] | 99 |
| **$Fe_2O_3$** | [%] | 0.02 |
| **$SiO_2$** | [%] | 0.01 |
| **$Na_2O$** | [%] | < 0.1 |
| **Loss on ignition (105 - 1000 °C)** | [%] | 17 |

| Physical properties | Unit | APYRAL® AOH 30 | APYRAL® AOH 40 | APYRAL® AOH 60 | ACTILOX® 200SM |
|---|---|---|---|---|---|
| **D50** | [µm] | 1.8 | 2.7 | 0.8 | 0.3 |
| **BET** | [m²/g] | 3 | 3.5 | 6 | 17 |
| **Oil absorption** | [ml/100g] | 28 | 27 | 30 | 36 |

## Surface treated functional fillers

Based on fine precipitated aluminium hydroxide (**APYRAL®**) as well as the Boehmite grades (**APYRAL® AOH** and **ACTILOX® B / SM**), ***Nabal****tec* offers a wide range of silanized products. Extreme product requirements, such as improved tracking resistance, reduced water uptake due to an increased hydrophobic content or an improved processing behavior are realized via specific silanized **APYRAL®** -types. Specific applications in liquid resin processes or in technical thermoplastics generate great benefits from surface treated Boehmite grades. The typical nomenclature of our products applies with the appendix of the surface coating functionality (see table below).

| Functional group | APYRAL® (40-120) | APYRAL® AOH (30-60) | ACTILOX® (B30 - 200SM) |
|---|---|---|---|
| **Aminosilane** | AS1 | AS1 | AS1 |
| **Epoxysilane** | ES1 | ES1 | ES1 |
| **Vinylsilane** | VS1 | VS1 | VS1 |
| **Hydrophobic stabilized** | HS1 | HS1 | HS1 |

# ACTILOX® PA

Based on functional fillers ***Nabal**tec* develops solid formulations to be used as process aids in diverse polymer processes.

**ACTILOX® PA** is a mineral based masterbatch containing silicone compounds as active components.

**ACTILOX® PA-14** is used as a process aid for highly filled mineral flame retardant compounds, like HFFR cable-compounds. Positive effects area 30 % increase in line speed, extremely reduced die drooling (die lip built up) and a reduction in the formation of burrs.

Additionaly **ACTILOX® PA-14** improves flame retardance and water absorption.

| Physical properties | | ACTILOX® PA-14 |
|---|---|---|
| **Specific density** | [g/cm³] | 1.43 |
| **Bulk density** | [kg/m³] | 600 |
| **Loss on ignition** | [%] | 48 |

**Calcined aluminas**
**NABALOX®**

**Synthetic sintered Mullite**
**SYMULOX® M 72**

**Synthetic refractory grain**
**NABALOX® K 85**

**α-$Al_2O_3$-based binder**
**NABACAST®**

**Ceramic bodies**
**GRANALOX®**

# NABALOX®

***Nabal**tec* produces calcined aluminium oxides for a wide variety of applications especially for the refractory and ceramic industry. Raw material is aluminium oxide. After further calcining refining continues. The raw material has been carefully chosen by quality control of a number of important parameters:

- chemical purity
- grain size distribution
- crystallite size
- crystal structure

The calcination process determines the α-$Al_2O_3$ content, structure, size and morphology of the primary crystallites. The required product properties are optimized and refined by grinding, air separation, sieving, granulation and shaping.

This provides **NABALOX®** aluminium oxides with a number of advantages:

- low sintering temperature
- wide sintering range
- flexible processing
- high sintered densities
- optimized flow properties
- optimized packing density

**NABALOX®** aluminium oxides allow the high requirements of our customers to be attained, namely:

- high wear and impact resistance
- excellent dielectric properties insulation
- high mechanical strength
- excellent high temperature properties
- dimensional accuracy
- optimized chemical resistance
- low water demand
- high thermal shock resistence
- long durability in kiln applications

## Calcined aluminas

**Applications:**

- chemical industry
- glass industry
- corundum
- refractory industry
- household ceramics
- wear-resistant ceramics
- electrical ceramics
- engineering ceramics

| Analysis | Unit | NO 104 RA | NO 105 | NO 105 RA | NO 105-71 RA |
|---|---|---|---|---|---|
| **$Al_2O_3$** [1)] | [%] | 99.8 | 99.6 | 99.8 | 99.8 |
| **$SiO_2$** | [%] | 0.02 | 0.02 | 0.02 | 0.02 |
| **$Na_2O$ total** | [%] | 0.1 | 0.3 | 0.1 | 0.1 |
| **$Fe_2O_3$** | [%] | 0.03 | 0.03 | 0.03 | 0.03 |
| **Specific surface area (BET)** | [m²/g] | 4 | 0.6 | 0.7 | 0.5 |
| **α-$Al_2O_3$-content** | [%] | 98 | 98 | 98 | 98 |
| **Median grain size** | [µm] | 80 | 80 | 80 | 80 |
| **Primary crystal size** | [µm] | 0.5 | 2 | 2 | 3 |
| **Specific density** | [g/cm³] | 3.9 | 3.9 | 3.9 | 3.9 |

1) material preheated at 1100 °C

## Hard calcined, ground aluminas

**Applications:**

- refractory industry
- wear-resistant ceramics

| Analysis | Unit | NO 115-71 | NO 115 G | NO 115-25 | NO 115 TC | NO 125 TC |
|---|---|---|---|---|---|---|
| **$Al_2O_3$ 1)** | [%] | 99.6 | 99.6 | 99.6 | 99.6 | 99.8 |
| **$SiO_2$** | [%] | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| **$Na_2O$ total** | [%] | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 |
| **$Fe_2O_3$** | [%] | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| **Specific surface area (BET)** | [m²/g] | 0.8 | 0.9 | 0.9 | 1 | 1 |
| **α-$Al_2O_3$-content** | [%] | 98 | 98 | 98 | 98 | 98 |
| **Median grain size** | [µm] | 5 | 6 | 5 | 4 | 4 |
| **Primary crystal size** | [µm] | 3 | 2 | 2 | 2 | 2 |
| **Ceramic properties 2)** | | | | | | |
| **Specific density** | [g/cm³] | 3.9 | 3.9 | 3.9 | 3.9 | 3.9 |
| **Green density 3)** | [g/cm³] | 2.27 | 2.33 | 2.30 | 2.31 | 2.29 |
| **Sintered density** | [g/cm³] | 3.10 4) | 3.44 4) | 3.41 4) | 3.51 4) | 3.66 4) |
| **Sintering temperature** | [°C] | 1750 | 1750 | 1750 | 1750 | 1750 |
| **Isotropic linear shrinkage** | [%] | 11 | 13 | 13 | 14 | 15 |

1) material preheated at 1100 °C,
2) typical values,
3) pressing moisture 4%, pressing strength 100 MPa uniax.,
4) for sinter tests 0.1% MgO is added

## Hard calcined, ground aluminas

**Applications:**

- refractory industry
- engineering ceramics

| Analysis | Unit | NO 135 | NO 315 | NO 325 |
|---|---|---|---|---|
| **$Al_2O_3$ 1)** | [%] | 99.6 | 99.6 | 99.7 |
| **$SiO_2$** | [%] | 0.03 | 0.03 | 0.03 |
| **$Na_2O$ total** | [%] | 0.3 | 0.3 | 0.1 |
| **$Fe_2O_3$** | [%] | 0.03 | 0.03 | 0.03 |
| **Specific surface area (BET)** | [m²/g] | 0.8 | 1.5 | 1.5 |
| **α-$Al_2O_3$-content** | [%] | 98 | 98 | 98 |
| **Median grain size** | [µm] | 5 | 3 | 3 |
| **Primary crystal size** | [µm] | 3 | 2 | 2 |
| **Ceramic properties 2)** | | | | |
| **Specific density** | [g/cm³] | 3.9 | 3.9 | 3.9 |
| **Green density 3)** | [g/cm³] | 2.33 | 2.37 | 2.34 |
| **Sintered density** | [g/cm³] | 3.10 4) | 3.54 4) | 3.74 4) |
| **Sintering temperature** | [°C] | 1750 | 1750 | 1750 |
| **Isotropic linear shrinkage** | [%] | 9 | 14 | 16 |

1) material preheated at 1100 °C,
2) typical values,
3) pressing moisture 4%, pressing strength 100 MPa uniax.,
4) for sinter tests 0.1% MgO is added

## Soft calcined, ground aluminas

**Applications:**

- refractory industry
- engineering ceramics

| Analysis | Unit | NO 265 | NO 113 | NO 313 |
|---|---|---|---|---|
| **$Al_2O_3$** [1] | [%] | 99.6 | 99.6 | 99.6 |
| **$SiO_2$** | [%] | 0.03 | 0.03 | 0.03 |
| **$Na_2O$ total** | [%] | 0.3 | 0.3 | 0.3 |
| **$Fe_2O_3$** | [%] | 0.03 | 0.03 | 0.03 |
| **Specific surface area (BET)** | [$m^2/g$] | 8 | 9 | 11 |
| **α-$Al_2O_3$-content** | [%] | 70-90 | 70-90 | 70-90 |
| **Median grain size** | [µm] | 6 | 3 | 2 |
| **Primary crystal size** | [µm] | < 0.5 | < 0.5 | < 0.5 |
| **Ceramic properties** [2] | | | | |
| **Specific density** | [$g/cm^3$] | 3.85 | 3.85 | 3.85 |
| **Green density** [3] | [$g/cm^3$] | n. d. [5] | 1.85 | 1.90 |
| **Sintered density** | [$g/cm^3$] | n. d. [5] | 3.48 [4] | 3.60 [4] |
| **Sintering temperature** | [°C] | - | 1750 | 1750 |
| **Isotropic linear shrinkage** | [%] | n. d. [5] | 20 | 21 |

1) material preheated at 1100 °C,
2) typical values,
3) pressing moisture 4%, pressing strength 100 MPa uniax.,
4) for sinter tests 0.1% MgO is added,
5) not detected

## (Super-) Reactive, monomodal aluminas

**Applications:**

- refractory industry
- wear-resistant ceramics

| Analysis | Unit | NO 615-10 | NO 625-10 |
|---|---|---|---|
| **$Al_2O_3$ 1)** | [%] | 99.6 | 99.8 |
| **$SiO_2$** | [%] | 0.03 | 0.03 |
| **$Na_2O$ total** | [%] | 0.3 | 0.1 |
| **MgO (doped)** | [%] | - | - |
| **$Fe_2O_3$** | [%] | 0.03 | 0.03 |
| **Specific surface area (BET)** | [m²/g] | 1.6 | 1.6 |
| **α-$Al_2O_3$-content** | [%] | 98 | 98 |
| **Median grain size** | [µm] | 2.5 | 2.5 |
| **Primary crystal size** | [µm] | 2 | 2 |
| **Ceramic properties 2)** | | | |
| **Specific density** | [g/cm³] | 3.9 | 3.9 |
| **Green density 3)** | [g/cm³] | 2.37 | 2.39 |
| **Sintered density** | [g/cm³] | 3.77 4) | 3.85 4) |
| **Sintering temperature** | [°C] | 1750 | 1750 |
| **Isotropic linear shrinkage** | [%] | 15 | 16 |

1) material preheated at 1100 °C,
2) typical values,
3) pressing moisture 4%, pressing strength 100 MPa uniax.,
4) for sinter tests 0.1% MgO is added,
5) not detected

| NO 715-10 | NO 725-10 | NO 613-10 | NO 713-10 RF | NO 713-10 | NO 713-10 MF |
|---|---|---|---|---|---|
| 99.6 | 99.8 | 99.7 | 99.7 | 99.7 | 99.8 |
| 0.03 | 0.03 | 0.05 | 0.05 | 0.05 | 0.05 |
| 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| - | - | - | - | 0.1 | - |
| 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| 2 | 2 | 6 | 7 | 7 | 7 |
| 98 | 98 | 95 | 95 | 95 | 95 |
| 2 | 2 | 1 | 0.8 | 0.8 | 0.8 |
| 2 | 2 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| | | | | | |
| 3.9 | 3.9 | 3.9 | 3.9 | 3.9 | 3.9 |
| 2.36 | 2.35 | 2.20 | n. d.[5)] | 2.25 | 2.32 |
| 3.80[4)] | 3.89[4)] | 3.88 | n. d.[5)] | 3.95 | 3.89 |
| 1750 | 1750 | 1600 | - | 1600 | 1600 |
| 15 | 17 | 18 | n. d.[5)] | 18 | 17 |

## Reactive, bimodal aluminas

**Applications:**

- refractory industry
- wear-resistant ceramics

| Analysis | Unit | NO 615-30[a)] | NO 625-30[b)] |
|---|---|---|---|
| **$Al_2O_3$ [1)]** | [%] | 99.6 | 99.7 |
| **$SiO_2$** | [%] | 0.05 | 0.05 |
| **$Na_2O$ total** | [%] | 0.2 | 0.1 |
| **$Fe_2O_3$** | [%] | 0.03 | 0.03 |
| **Specific surface area (BET)** | [m²/g] | 5 | 3 |
| **α-$Al_2O_3$-content** | [%] | 96 | 96 |
| **Median grain size** | [µm] | 2 | 2 |
| **Primary crystal size** | [µm] | 0.5/2 | 0.5/2 |
| **Ceramic properties[2)]** | | | |
| **Specific density** | [g/cm³] | 3.9 | 3.9 |
| **Green density[3)]** | [g/cm³] | 2.74 | n. d.[4)] |
| **Sintered density** | [g/cm³] | 3.92 | n. d.[4)] |
| **Sintering temperature** | [°C] | 1725 | - |
| **Isotropic linear shrinkage** | [%] | 13 | n. d.[4)] |

a) ceramic grade
b) refractory grade

1) material preheated at 1100 °C,
2) typical values,
3) pressing moisture 4%, pressing strength 100 MPa uniax.,
4) not detected

- hight temperature ceramics

| NO 625-31[a)] | NO 530[b)] | NO 645[b)] | NO 652[b)] | NO 660[b)] |
|---|---|---|---|---|
| 99.7 | 99.7 | 99.7 | 99.7 | 99.7 |
| 0.05 | 0.03 | 0.05 | 0.05 | 0.05 |
| 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 0.03 | 0.02 | 0.03 | 0.03 | 0.03 |
| 4 | 3.5 | 4 | 3 | 3 |
| 96 | 96 | 96 | 96 | 96 |
| 2 | 1.5 | 2 | 3 | 2 |
| 0.5/2 | 0.5/2 | 0.5/2 | 0.5/2 | 0.5/2 |
| | | | | |
| 3.9 | n. d | 3.9 | 3.9 | 3.9 |
| 2.75 | n. d. | n. d. | n. d. | n. d. |
| 3.93 | n. d. | n. d. | n. d. | n. d. |
| 1725 | - | - | - | - |
| 12 | n. d. | n. d. | n. d. | n. d. |

## Polishing aluminas

The special qualities of **NABALOX®** aluminas are successfully used worldwide as polishing media. The **NABALOX®** polishing oxide range offers a broad spectrum of soft and hard calcined aluminas for the various areas of industrial surface finishing.

A multitude of **NABALOX®** types are used for the production of polishing pastes and emulsions for almost any material group, such as metal, stone, plastic, car paint, semiconductors, special glasses and many others. The agglomerates and primary crystals of the aluminas have a direct influence on the quality of the surfaces to be finished and will be determined by the following parameters:

**The primary crystal size,**
or the primary grain, is the body which directly causes material abrasion during polishing. This size will determine the dimension and type of the material abrasion and is thus primarily responsible for the achievable surface quality. Small primary crystals cause minor surface roughness with only minor material abrasion and therefore induce a high surface quality. With large primary crystals, the surface roughness and material abrasion will be correspondingly higher.

**The secondary grain**
represents a cluster (agglomerate) of primary crystals.
During the polishing process the secondary grain will be destroyed by mechanical action, leading to the release of primary crystals of several hundred nanometers to µm size.

Therefore the polishing process begins and a defined abrasion rate will be induced. The initial abrasion rate is reduced by the decomposition of the agglomerate and a polishing action begins, which is decisive for the final surface quality. Apart from the grain size, the structure of the grain cluster will also decisively influence the oil absorption value.

**The grain size distribution**
reflects the distribution of the different grain size classes (fractions), relative to the secondary grains.
By tailoring the production process it is possible to manufacture a broad spectrum of different polishing types which are adjusted to the various finishing problems of a wide variety of materials. The following tables are intended to provide an overview of the available qualities.

| Typical chemical analysis | [%] |
|---|---|
| $Al_2O_3$ | > 99 |
| $SiO_2$ | 0.04 |
| $Fe_2O_3$ | 0.03 |

| | Abrasivity[3] | D50 [µm][4] | D90 [µm][4] | BET [m²/g][5] | Oil absorption [%][6] |
|---|---|---|---|---|---|
| **Very hard calcined aluminas** | | | | | |
| **α-$Al_2O_3$[1]: > 98 % - primary crystal size[2]: 3 µm, platelets** | | | | | |
| **NO 205-71** | ***** | 55 | 90 | 0.6 | 35-45 |
| **NO 230** | **** | 8 | 45 | 0.6 | 15-25 |
| **NO 115-71** | *** | 6 | 30 | 0.7 | 15-25 |
| **NO 235** | ** | 4 | 10 | 0.8 | 10-20 |
| **Hard calcined aluminas** | | | | | |
| **α-$Al_2O_3$[1]: 95 - 98 % - primary crystal size[2]: 2 µm** | | | | | |
| **NO 205 G** | **** | 80 | 120 | 0.7 | 30-40 |
| **NO 255** | *** | 70 | 110 | 0.8 | 30-40 |
| **NO 255 F** | *** | 60 | 95 | 0.8 | 30-40 |
| **NO 250** | ** | 50 | 80 | 0.8 | 30-40 |
| **NO 225** | ** | 8 | 35 | 0.8 | 20-30 |
| **NO 275** | ** | 6 | 30 | 0.8 | 15-25 |
| **NO 295** | ** | 5 | 25 | 0.9 | 15-25 |
| **NO 215 G** | ** | 5 | 15 | 0.9 | 15-25 |
| **NO 215** | * | 4 | 15 | 0.9 | 10-20 |
| **Soft calcined aluminas** | | | | | |
| **α-$Al_2O_3$[1]: 70 - 90 % - primary crystal size[2]: 0.1 - 0.5 µm** | | | | | |
| **NO 202 II** | *** | 80 | 120 | 7 | 40-50 |
| **NO 265** | ** | 6 | 40 | 8 | 25-35 |
| **NO 212** | ** | 5 | 35 | 9 | 25-35 |
| **NO 313** | * | 2.5 | 20 | 11 | 20-30 |
| **Very soft calcined aluminas** | | | | | |
| **α-$Al_2O_3$[1]: 0 - 5 % - primary crystal size[2]: 0.01 - 0.05 µm** | | | | | |
| **NO 201** | *** | 80 | 120 | 75 | 50-60 |
| **NO 221-40** | ** | 40 | 70 | 75 | 45-55 |
| **NO 221-30** | * | 30 | 50 | 75 | 40-50 |

1) XRD, 2) SEM, 3) comparative polishing test, 4) laser granulometry Cilas 1064,
5) DIN ISO 9277, 6) DIN EN ISO 787 part 5

## Soft calcined, fine ground aluminas

As a result of a systematic development of its production processes ***Nabal***tec can offer a completely new group of soft calcined aluminas with unique properties. The new generation of soft calcined aluminias of the trademark **NABALOX®** is characterized by

- constant high specific surface area, up to 75 m²/g
- narrow grain distribution with low coarse fraction
- a low batch to batch variation concerning grain size and purity
- a low tendency to agglomeration and thus improved dispersibility compared to conventional ground aluminas.

### Refractories

Due to their typical primary crystal size of 0.2 µm and below, the soft calcined aluminas of **NABALOX®** are an ideal viscosity adjusting agent for gunning mixes and mouldable materials. It is therefore possible to achieve the desired consistency without organic plasticisers or clay minerals which guarantees a high refractoriness.

### Glazes

Because of its high reactivity and constant grain size, **NABALOX®** soft calcined aluminas are the ideal $Al_2O_3$ carrier for high-quality glazes and stains.

### Ceramic inks

The defined fine grain size distribution of **NABALOX®** soft calcined aluminas allows them to be used for digital printing with ceramic inks, without the need of further refinement steps.

### Polishing media

Low agglomeration, narrow particle size distribution and constant oil absorption are the properties of **NABALOX®** soft calcined aluminas. These characteristics guarantee outstanding results in applications, such as suspensions and pastes.

### Technical ceramics

Because of its high specific surface area **NABALOX®** soft calcined aluminas are ideally suited for the manufacture of catalyst supports and filtration media with high porosity and a low shrinkage tolerance.

## Soft calcined, fine ground aluminas

| | D10 [µm] | D50 [µm] | D90 [µm] | BET [$m^2/g$] |
|---|---|---|---|---|
| **Very soft calcined γ-aluminas** | | | | |
| **Primary crystal size: 0.01 - 0.05 µm, $Na_2O$ ≤ 0.3 %, $Al_2O_3$ ≤ 99.5 %** | | | | |
| **NO 481** | 0.5 | 2.6 | 6 | 75 |
| **NO 681** | 0.4 | 2 | 4 | 75 |
| **Soft calcined α-aluminas** | | | | |
| **Primary crystal size: 0.1 - 0.5 µm, $Na_2O$ ≤ 0.3 %, $Al_2O_3$ ≤ 99.5 %** | | | | |
| **NO 183** | 0.8 | 10 | 50 | 10 |
| **NO 283** | 0.7 | 5 | 25 | 10 |
| **NO 383** | 0.6 | 3 | 12 | 11 |
| **NO 483** | 0.5 | 2 | 7 | 11 |
| **NO 683** | 0.4 | 1 | 4 | 11 |
| **NO 783** | 0.4 | 0.8 | 2 | 12 |
| **Soft calcined, low soda α-aluminas** | | | | |
| **Primary crystal size: 0.2 - 0.8 µm, $Na_2O$ ≤ 0.1 %, $Al_2O_3$ ≥ 99.8 %** | | | | |
| **NO 384** | 0.6 | 3 | 15 | 5 |
| **NO 484** | 0.5 | 2 | 9 | 6 |
| **NO 684** | 0.4 | 1 | 3 | 6 |
| **NO 784** | 0.4 | 0.8 | 2 | 7 |

# SYMULOX® M 72
# synthetic sintered Mullite

Synthetic sintered Mullite from ***Nabal**tec* is available under the trade name **SYMULOX® M 72**. It is used as high quality raw material in a wide range of refractory applications. The homogeneous phase constitution and very low amount of impurities offer considerable advantages over naturally occurring alumosilicates. The synthesized Mullite product shows very good chemical uniformity, high refractory properties and excellent high temperature stability.

The constant high quality of **SYMULOX® M 72** is based on a careful selection and quality control of all raw materials. After pelletizing or briquette forming, the raw materials are sintered close to the melting temperature. A very homogeneous temperature distribution during the sintering process leads to constant high Mullite forming rates. After sintering the pieces are crushed, milled and fractionized.

**M 72** standard grain sizes:

| | |
|---|---|
| K1 | 0 - 0.5 mm |
| K2 | 0.5 - 1.5 mm |
| K3 | 1.5 - 3.0 mm |
| K4 | 3.0 - 5.0 mm |
| pellets | > 8.0 mm |

**M 72** standard grain sizes:

| | |
|---|---|
| K0 C | D50: 3 - 5 µm |
| K0 | D50: 7 - 15 µm |
| K0 coarse | D50: 15 - 30 µm |

Customer-specific grain sizes can be offered on request.

| Chemical composition | Unit | M 72 |
|---|---|---|
| **$Al_2O_3$** | [%] | 72 |
| **$SiO_2$** | [%] | 26 |
| **$Fe_2O_3$** | [%] | 0.3 |
| **$TiO_2$** | [%] | 0.2 |
| **CaO** | [%] | 0.05 |
| **MgO** | [%] | 0.1 |
| **$Na_2O$** | [%] | 0.2 |
| **$K_2O$** | [%] | 0.6 |
| **Mineralogical composition** | | |
| **Mullite** | [%] | 90 - 95 |
| **Glassy phase** | [%] | 5 - 10 |
| **Corundum** | [%] | ~1 |
| **Physical properties*** | | |
| **Bulk density** | [g/cm³] | 2.8 |
| **Open porosity** | [%] | 1.5 |
| **Water absorption** | [%] | 1 |

* measured on pellets

# NABALOX® K 85 synthetic refractory grain

**K 85** contains at minimum 85 % $Al_2O_3$ and about 14 % $SiO_2$.
As a result of this high $Al_2O_3$ -content and a low ration of secondary components of max. 1 % a high refractoriness is ensured. Due to the high sythesis temperature, close to the theoretical melting point of about 1850 °C, the material has a low open porosity accompanied with a low water absorption and a phase component of at least 50 % high refractory corundum.
**K 85** offers a high-quality, synthetic alternative to less pure refractory raw materials, such as those of the sillimanite group or the raw materials sintered bauxite and brown fused corundum. In terms of refractoriness, **K 85** belongs to the group of white, synthetic raw materials as well as the synthetic sintered Mullite **(SYMULOX® M 72)** and tabular aluminas and their fused derivates. The synthetic raw material **K 85** is an excellent base as a main component for shaped and unshaped $Al_2O_3$-rich refractory products with application temperatures up to 1800 °C.

High temperature creep and corrosive attack in refractories is based mainly on the matrix properties. Reasoned by lower porosity of the refractory grain related to its high production temperature.
For this reason, for refractory products containing even small amounts of $SiO_2$** in the matrix, **K 85** can be used as a supporting grain without any degradation of high temperatura properties as compred to e. g. tabular alumina. Moreover **K 85** has, due to its phase composition, a lower density and thermal conductivity than pure alumina. These unique advantages are based on reduced heat loss of high-temperature facilities. Standard delivery size are pellets > 8 mm.

** (e. g. microsilica for deflocculated corundum concretes, kaolin as a pressing aid for corundum- or other mullite-ceramic bonds).

| Chemical composition | Unit | K 85 |
|---|---|---|
| **$Al_2O_3$** | [%] | 85 |
| **$SiO_2$** | [%] | 14 |
| **$Fe_2O_3$** | [%] | 0.11 |
| **$TiO_2$** | [%] | 0.08 |
| **CaO** | [%] | 0.04 |
| **MgO** | [%] | 0.1 |
| **$Na_2O$** | [%] | 0.2 |
| **$K_2O$** | [%] | 0.4 |
| **Mineralogical composition** | | |
| **Corundum** | [%] | ~ 45 - 50 |
| **Mullite** | [%] | ~ 45 - 50 |
| **Physical properties*** | | |
| **Bulk density** | [g/cm³] | 3.2 |
| **Open porosity** | [%] | 1.1 |
| **Water absorption** | [%] | 0.3 |

* measured on pellets

# NABACAST®
# hydraulic binder, based on α-$Al_2O_3$

As a result of our wide range of calcined and reactive aluminas, ***Nabal**tec* AG is a respected supplier of refractory raw materials produced to a high-quality standard.
For the production of a new class of no-cement-castables **NABACAST®**, an innovative cement-free binder based on reactive alumina was developed by ***Nabal**tec* AG. The products of the **NABACAST®** product line simultaneously fulfill several of the desired functions in a castable and act as a binder, a micro-filler and a deflocculant.

### Cement free
**NABACAST®** contains only alumina and magnesia. This makes it possible to produce unshaped refractory products containing only the refractory phases of corundum and spinel.

### Corrosion resistant
As a result of its completely CaO-free phase constitution, **NABACAST®** exhibits an optimal chemical resistance. By using **NABACAST®** the life time expectancy of refractory parts which are exposed to corrosive slag attack can be improved significantly.

### Binder
**NABACAST®** is a novel hydraulic binder that reacts with water under the formation of hydrates which causes consolidation of the refractory concrete.

### Micro-filler
With its small particle size < 3 µm **NABACAST®** can fulfill the same function as reactive alumina in established, cement-containing formulations.

### Deflocculant
There is no need of a supplementary addition of deflocculant.

### Practice compatible
**NABACAST®** has the ability to simultaneously replace several recipe components of an ordinary cement-containing formulation.

### Controllable
By targeted mixing of **NABACAST®** products with different setting rates the processability of a **NABACAST®** concrete can be precisely adjusted.

### Highly refractory
**NABACAST®**-bonded refractory materials do not form a liquid phase at temperatures up to 1700 °C. This guarantees excellent characteristics regarding hot modulus of rupture and refractoriness under load.

| Characteristics | Unit | NABACAST® RM 16 |
|---|---|---|
| **$Al_2O_3$** | [%] | 92 |
| **Setting time*** | [h] | 5 |
| **Cold crushing strength*** | [MPa] | 35 |

* as measured by a model formulation

# GRANALOX®
# ceramic bodies

Based on its own alumina range, ***Nabal**tec* produces high $Al_2O_3$-containing bodies in accordance with the standards C 786, C 795 and C 799 of IEC 672-1 with 92 - 99.8 % $Al_2O_3$. These ready-formulated raw materials are ready for pressing and can be formed directly into ceramic parts via uniaxial or cold isostatic pressing.

The quality of the raw materials is of key importance for all properties of the final ceramic parts. As an alumina producer, ***Nabal**tec* can control and guarantee constant physical and chemical properties of the material (grain distribution, primary crystallite size, bulk density, specific surface, grinding behaviour and reactivity).

***Nabal**tec*'s ceramic bodies are produced under rigid quality control of green and sintered density, shrinkage, porosity, loss on ignition and granulate size. The properties of the α-$Al_2O_3$ (corundum) are tailored to the application areas in which the material is used such as wear resistance, high temperature stability, good electrical insulation, thermal conductivity and corrosion resistance.

Ceramic bodies with 92 % $Al_2O_3$ predominate in wear resistance applications. Low electrical conductivity and dielectric loss together with good mechanical properties and thermal conductivity are obtained from ceramic bodies NM 96. The highest demands of bending strength, thermal shock resistance, resistance to acid and alkaline attack, abrasion and wear resistance are met by the grades of NM 99.

As a special service, ***Nabal**tec* offers its customers the supply of material with individual binder compositions.

The ceramic bodies free of binder can be used by an addition of approx. 20 % water for slip casting or by addition of suitable plasticizers for other moulding technologies (e.g. extrusion, injection moulding, tapecasting).

| Ceramic body | Fields of application |
|---|---|
| **NM 92** | wear resistant ceramics, standard machinery parts |
| **NM 96** | electrical insulating and polishable machinery parts, chemical resistant ceramics, ballistic protection |
| **NM 98** | machinery parts, ballistic protection |
| **NM 99** | engineering ceramics |

## Ceramic bodies, ready for pressing

(ready formulated raw-materials for production of high-grade aluminium oxide ceramics)

| Chemical analysis | Unit | NM 9212 E | NM 9212 F | NM 9212 G |
|---|---|---|---|---|
| **$Al_2O_3$** | [%] | 92 | 92 | 92 |
| **$Na_2O$** | [%] | 0.1 | 0.1 | 0.1 |
| **Physical analysis** | | | | |
| **Primary crystal size** | [µm] | 2 | 2 | 2 |
| **Median granulate size** | [µm] | 200 | 100 | 190 |
| **Bulk density** | [kg/m³] | 1280 | 1220 | 1270 |
| **Granulate-moisture** | [%] | 0.4 | 0.3 | 0.4 |
| **Loss on ignition[1)]** | [%] | 6.0 | 6.6 | 6.7 |
| **Processing characteristics[2)]** | | | | |
| **Sintering temperature** | [°C] | 1580 | 1580 | 1580 |
| **Dwell time** | [h] | 2 | 2 | 2 |
| **Sintered density** | [g/cm³] | 3.70 | 3.70 | 3.70 |
| **Isotropic linear shrinkage** | [%] | 14.6 | 15.3 | 14.9 |

1) RT - maximum sintering temperature,
2) Pressing strength 100 MPa, for NM 9922 I 180 MPa,

| NM 9510 F | NM 9620 | NM 9620 F | NM 9622 | NM 9622 FS | NM 9622 W | NM 9634 F |
|---|---|---|---|---|---|---|
| 95 | 96 | 96 | 96 | 96 | 96 | 96 |
| 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| | | | | | | |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 100 | 200 | 100 | 200 | 100 | 200 | 100 |
| 1260 | 1250 | 1250 | 1280 | 1220 | 1280 | 1280 |
| 0.2 | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 5.6 | 3.8 | 4.0 | 4.1 | 4.8 | 3.6 | 3.7 |
| | | | | | | |
| 1620 | 1620 | 1620 | 1650 | 1650 | 1650 | 1620 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 3.72 | 3.71 | 3.74 | 3.80 | 3.79 | 3.79 | 3.80 |
| 14.8 | 14.8 | 13.5 | 14.5 | 15.0 | 14.7 | 14.0 |

## Ceramic bodies, ready for pressing

(ready formulated raw-materials for production of high-grade aluminium oxide ceramics)

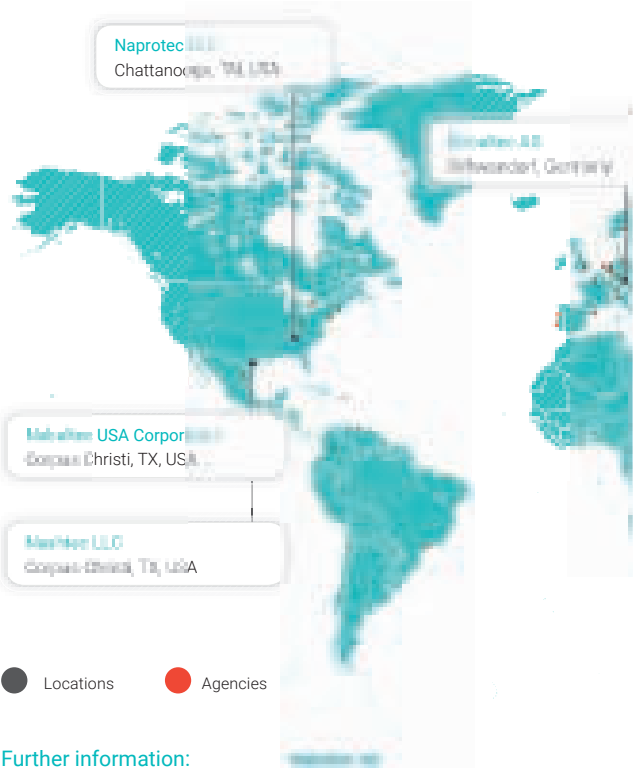
| Chemical analysis | Unit | NM 9816 | NM 9922 | NM 9922 I |
|---|---|---|---|---|
| **$Al_2O_3$** | [%] | 98 | 99.7 | 99.7 |
| **$Na_2O$** | [%] | 0.1 | 0.1 | 0.1 |
| **Physical analysis** | | | | |
| **Primary crystal size** | [µm] | 2 | < 1 | < 1 |
| **Median granulate size** | [µm] | 200 | 190 | 70 |
| **Bulk density** | [kg/m³] | 1290 | 1200 | 1150 |
| **Granulate-moisture** | [%] | 0.4 | 0.5 | 0.3 |
| **Loss on ignition[1)]** | [%] | 4.4 | 3.1 | 4.2 |
| **Processing characteristics[2)]** | | | | |
| **Sintering temperature** | [°C] | 1650 | 1600 | 1600 |
| **Dwell time** | [h] | 2 | 2 | 2 |
| **Sintered density** | [g/cm³] | 3.85 | 3.92 | 3.90 |
| **Isotropic linear shrinkage** | [%] | 14.7 | 17.2 | 16.8 |

1) RT - maximum sintering temperature,
2) Pressing strength 100 MPa, for NM 9922 I 180 MPa

| | | Ceramic bodies free of binder (B) | | | | |
|---|---|---|---|---|---|---|
| **NM 9970 F** | **NM 9980 F** | **NM 9212 B** | **NM 9622 B** | **NM 9915 B** | **NM 9922 B** | **NM 9980 B** |
| 99.7 | 99.8 | 92 | 96 | 99.7 | 99.7 | 99.8 |
| 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| | | | | | | |
| < 1 | < 1 | 2 | 2 | 0.5/2 | < 1 | < 1 |
| 100 | 100 | 200 | 200 | 170 | 190 | 100 |
| 1160 | 1100 | - | - | - | - | - |
| 0.3 | 0.3 | max. 0.5 | max. 0.5 | max. 0.5 | max. 0.5 | max. 0.5 |
| 3.6 | 3.8 | - | - | - | - | - |
| | | | | | | |
| 1600 | 1600 | 1580 | 1650 | 1720 | 1600 | 1600 |
| 2 | 2 | 2 | 1 | 2 | 1 | 2 |
| 3.92 | 3.93 | 3.70 | 3.80 | 3.88 | 3.92 | 3.93 |
| 16.7 | 20.2 | - | - | - | - | - |

# NABALTEC
woldwide

Visit us at our website www.nabaltec.de where you will find the latest company updates and recent versions of all available certificates free for download as PDF-documents.

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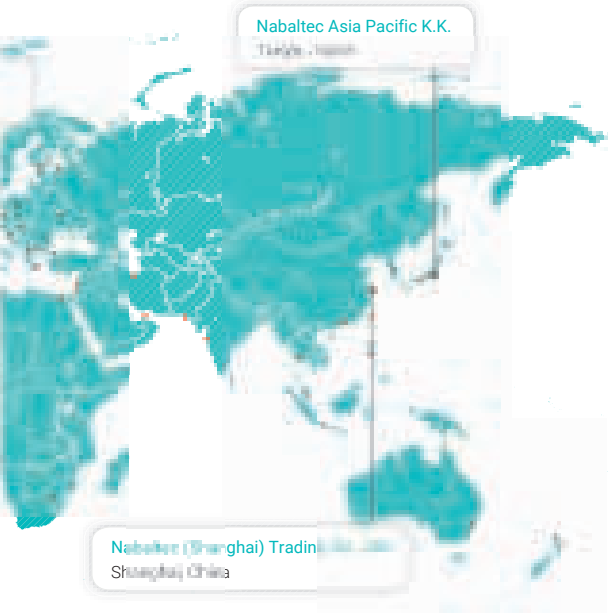


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# Quality
control

Our quality control department is equipped with state-of-the-art analytical devices.

| | |
|---|---|
| **Moisture content (at 105 °C) of fillers** | DIN EN ISO 787-2 |
| **Loss on ignition (105 - 1000 °C)** | ISO 806 |
| **Bulk density** | DIN EN ISO 23145-2 |
| **Angle of response** | ISO 902 |
| **Oil absorption value** | DIN EN ISO 787-5 |
| **Sieve analysis by testing sieves** | DIN 66165-2 |
| **Whiteness** | DIN 53145-1 |
| **Colorimetry** | DIN EN ISO 11664-4 |
| **pH-value** | DIN EN ISO 787-9 |
| **Specific conductivity** | DIN EN ISO 787-14 |
| **Chemical composition** | DIN EN 725-1 |
| **Specific surface area** | DIN ISO 9277 |
| **Specific density*** | DIN EN 993-1 |
| **Water absorption, open porosity*** | DIN EN 993-1 |
| **Grain size distribution** | ISO 13320 / ISO 22412 |

Laser diffraction
Dynamic light scattering
X-ray diffraction (XRD)
Scanning electron microscopy (SEM)
Plasma emission spectroscopy (ICP-OES)
Energy dispersive X-ray analysis (EDX)

* measured on bulk samples (mullite, ceramic bodies)

# Sieve size information

| DIN-Meshes per | | Sieve aperture per | | USA standard | Tyler | British standard | AFNOR | DIN-Meshes per | | Sieve aperture per | | USA standard | Tyler | British standard | AFNOR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| cm | cm² | µm | Inch | Mesh | | Mod. | | cm | cm² | µm | Inch | Mesh | | Mod. | |
| | | 1 | | (12500) | | | | | | | | | | | |
| (5000) | | 2.5 | .0001 | (5000) | | | | | | 589 | .0232 | | 28 | | |
| (1000) | | 5 | .0002 | (2500) | | | | | | 590 | .0232 | 30 | | | |
| (500) | | 10 | .0004 | (1250) | | | | | | 599 | .0236 | | | 25 | |
| (250) | (60000) | 20 | .0008 | 625 | | | | 10 | 100 | 600 | .0236 | | | | |
| | | 37 | .0014 | 400 | | | | | | 630 | .0248 | | | | 29 |
| | | 40 | .0016 | | | | 17 | | | 699 | .0275 | | | 22 | |
| | | 43 | .0017 | | 325 | | | | | 701 | .0276 | | 24 | | |
| 130 | (16900) | 44 | .0017 | 325 | | | | | | 710 | .0280 | 25 | | | |
| | | 50 | .0020 | | | | 18 | 8 | 64 | 750 | .0295 | | | | |
| 120 | (14400) | 53 | .0021 | 270 | 270 | 300 | | | | 800 | .0315 | | | | 30 |
| 100 | 10000 | 60 | .0023 | | | | | | | 833 | .0328 | | 20 | | |
| | | 61 | .0024 | | 250 | | | | | 840 | .0331 | 20 | | | |
| | | 62 | .0024 | 230 | | | | | | 853 | .0036 | | | 18 | |
| | | 63 | .0025 | | | | 19 | | | 991 | .0390 | | 16 | | |
| | | 66 | .0026 | | | 240 | | 6 | 36 | 1000 | .0394 | 18 | | | 31 |
| | | 74 | .0029 | 200 | 200 | | | | | 1003 | .0395 | | | 16 | |
| 80 | 6400 | 75 | .0029 | | | | | | | 1168 | .0460 | | 14 | | |
| | | 76 | .0030 | | | 200 | | | | 1190 | .0469 | 16 | | | |
| | | 80 | .0032 | | | | 20 | 5 | 25 | 1200 | .0472 | | | | |
| | | 88 | .0035 | 170 | | | | | | 1204 | .0474 | | | 14 | |
| | | 89 | .0035 | | 170 | 170 | | | | 1250 | .0492 | | | | 32 |
| 70 | 4900 | 90 | .0036 | | | | | | | 1397 | .0550 | | 12 | | |
| 60 | 3600 | 100 | .0039 | | | | 21 | | | 1405 | .0553 | | | 12 | |
| | | 104 | .0041 | | 150 | 150 | | | | 1410 | .0555 | 14 | | | |
| | | 105 | .0041 | 140 | | | | 4 | 16 | 1500 | .0590 | | | | |
| 50 | 2500 | 120 | .0047 | | | | | | | 1600 | .0630 | | | | 33 |
| | | 124 | .0049 | | 115 | 120 | | | | 1651 | .0650 | | 10 | | |
| | | 125 | .0049 | 120 | | | 22 | | | 1676 | .0660 | | | 10 | |
| | | 147 | .0058 | | 100 | | | | | 1680 | .0661 | 12 | | | |
| | | 149 | .0059 | 100 | | | | | | 1981 | .0780 | | 9 | | |
| 40 | 1600 | 150 | .0059 | | | | | 3 | 9 | 2000 | .0787 | 10 | | | 34 |
| | | 152 | .0060 | | | 100 | | | | 2057 | .0810 | | | 8 | |
| | | 160 | .0063 | | | | 23 | | | 2362 | .0930 | | 8 | | |
| | | 175 | .0069 | | 80 | | | | | 2380 | .0937 | 8 | | | |
| | | 177 | .0070 | 80 | | | | | | 2411 | .0949 | | | 7 | |
| | | 178 | .0070 | | | 85 | | 2.4 | 6 | 2500 | .0985 | | | | 35 |
| 30 | 900 | 200 | .0079 | | | | 24 | | | 2794 | .1100 | | 7 | | |
| | | 208 | .0082 | | 65 | | | | | 2812 | .1107 | | | 6 | |
| | | 210 | .0083 | 70 | | | | | | 2830 | .1110 | 7 | | | |
| | | 211 | .0083 | | | 72 | | 2 | 4 | 3000 | .1180 | | | | |
| | | 246 | .0097 | | 60 | | | | | 3150 | .1240 | | | | 36 |
| 24 | 576 | 250 | .0098 | 60 | | | 25 | | | 3327 | .1310 | | 6 | | |
| | | 251 | .0099 | | | 60 | | | | 3380 | .1320 | 6 | | | |
| | | 295 | .0116 | | 48 | 52 | | | | 3962 | .1560 | | 5 | | |
| | | 297 | .0117 | 50 | | | | 1.5 | | 4000 | .1570 | 5 | | | 37 |
| 20 | 400 | 300 | .0118 | | | | | | | 4699 | .1850 | | 4 | | |
| | | 315 | .0123 | | | | 26 | | | 4760 | .1870 | 4 | | | |
| | | 350 | .0138 | 45 | | | | 1.2 | 1.5 | 5000 | .1970 | | | | 38 |
| | | 351 | .0138 | | 42 | | | | | 5613 | .2210 | | 3.5 | | |
| | | 353 | .0139 | | | 44 | | | | 5660 | .2230 | 3.5 | | | |
| 16 | 256 | 400 | .0158 | | | | 27 | 1 | 1 | 6000 | .2300 | | | | |
| | | 417 | .0164 | | 35 | | | | | 6300 | .2480 | | | | 39 |
| | | 420 | .0165 | 40 | | | | | | 6680 | .2630 | | 3 | | |
| (14) | (196) | 422 | .0166 | | | 36 | | | | 6730 | .2650 | 3 | | | |
| | | 495 | .0195 | | 32 | | | | | 7925 | .3120 | | 2.5 | | |
| 12 | 144 | 500 | .0197 | 35 | | 30 | 28 | | | 8000 | .3150 | 2.5 | | | 40 |

# Location
certified

The high standard of ***Nabal****tec* AG management systems which we set up at our facility in Schwandorf is regularly certified by the TÜV committee.

### Schwandorf

- ISO 9001 (Quality Management System)
- ISO 14001 (Environmental Management System)
- OHSAS 18001 (Occupational Health and Safety Assessment Series)
- ISO 50001 (Energy Management System)

Visit us at our website www.nabaltec.de where you will find the latest company updates and recent versions of all available certificates free for download as PDF-documents.

# Conversion table

| Metric unit | Physical category | Conversion factor (approx.) | US unit |
|---|---|---|---|
| °C | temperature | x 1.8 + 32 | °F |
| kg | weight | x 2.21 | lb (pounds) |
| to (metric) | weight | x 1.1 | tn. sh. (short ton) |
| l | volume | x 0.264 | gal |
| $m^2$ | area | x 10.76 | $ft^2$ |
| mm | length | see table p. 38 | mesh |
| µm | length | see table p. 38 | mesh |
| kW/h | energy | x 3412.13 | BTU/h |

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