

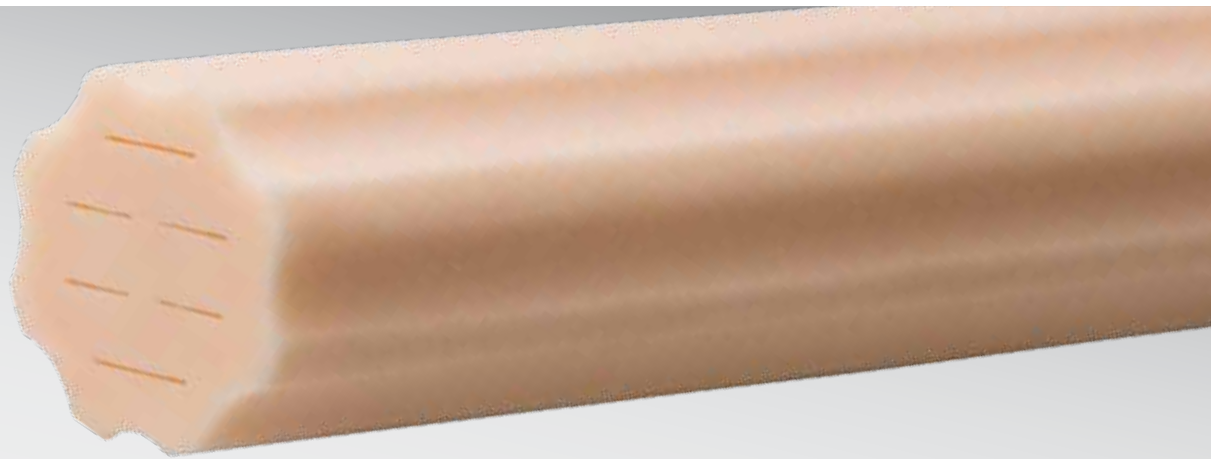
Components for High-Temperature Applications

FRIALIT®-DEGUSSIT® High-Performance Ceramics



For Longer Operational Lifetimes at High Temperatures

FRIALIT®-DEGUSSIT® High-Performance Ceramics



Friatec works photo

The quality of materials used in high-temperature applications is of utmost importance. Components made of FRIALIT®-DEGUSSIT® High-Performance Ceramics have fully proved their worth in a variety of demanding applications in the glass and metal-working industry, as well as in the field of process and analytical technology.

Extreme resilience

In a variety of applications, even the so-called high-performance alloys are pushed to their very limit. Excessive corrosion or insufficient creep strength impose limitations on the use of metallic components. Components made of FRIALIT-DEGUSSIT High-Performance Ceramics are extremely resistant to heat, corrosion and high voltages.

Moreover, their excellent stability of shape and full resistance to wear ensure an exceptionally long lifetime in terms of functionality.

Temperatures >1600 °C

The most varied range of products made of FRIALIT-DEGUSSIT High-Performance Ceramics, such as tubes, rods and crucible or components manufactured to customer specifications, are highly efficient.

The outstanding purity of the materials and excellent workmanship allow temperatures reaching even >1600 °C. In many operating environments it is just minor differences that determine the lifetime of a product.

150 years experience

We provide you with the benefit of around 150 years of experience in the manufacture of ceramics, combined with 60 years of expertise in the field of high-performance ceramics.

For each specific set of requirements our experts from design, development and manufacture develop optimum solutions made of high-performance ceramics. Their focus is fully directed at the needs of the customer, with whom they work in close contact throughout the process. The result is ceramic components that meet the very highest expectations.

Ceramics for Thermal Process Technology

Comparison of variations in quality



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The results of a comparative, international study of aluminium-oxide tubes generally available on the market show the advantages of DEGUSSIT AL23 and DEGUSSIT AL24.

Corrosion resistance

DEGUSSIT AL23 and DEGUSSIT AL24 show no corrosion phenomenon after 72 hours of exposure to boiling sulfuric acid. Other aluminium-oxide materials display the typical characteristics of inter-crystalline corrosion.

This is shown by the blue-coloured solution infiltration of the leached grain boundaries in the cross-section of the ceramics (Pict. 2, p. 5). Low levels of purity lead to an extremely low degree of durability.

Stability of shape

The degree of deformation of rods of the same dimension and with different aluminium-oxide materials after being maintained at a temperature of 1700 °C for many hours is shown in pict.1, p.5. DEGUSSIT AL24 and DEGUSSIT AL23 exhibit an extraordinary stability of shape, even under the most severe conditions.

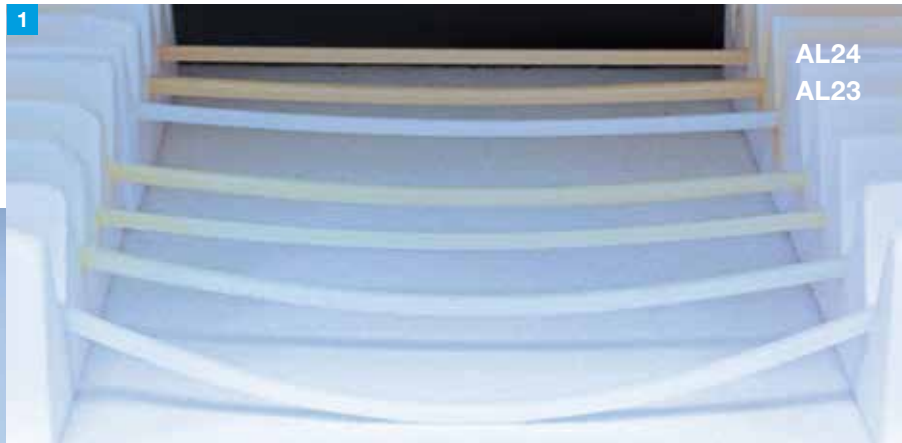
Summary

DEGUSSIT AL23 - as a densely-sintered aluminium-oxide ceramic material -

provides the ideal combination of shape stability and resistance to corrosion. DEGUSSIT AL24, developed especially for use in high-temperature technologies, is the ideal solution when confronted with the stresses presented by both high temperatures and corrosive atmospheres. Decades of experience that our customers have made with our products speaks for itself.

Detailed information on the study and its results are available at: www.friatec.de

1 Deformation of rods at high temperature. At the back, DEGUSSIT AL24 and DEGUSSIT AL23 and, at the front, products from other manufacturers



2 DEGUSSIT AL23 has the highest degree of durability



3 Crucibles and boats made of DEGUSSIT AL23

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Analysis

Reliability and precision with DEGUSSIT Oxide Ceramics



High quality during analysis leads to reliable and precise findings. DEGUSSIT Ceramics provides these, even under the most extreme environmental conditions.

Dilatometry

Dilatometry (DIL) is used for high-precision measurement of temperature-dependant dimensional changes to solids, melts, powders and pastes at programmed temperature changes.

The horizontal dilatometer measurement system is equipped with two high-resolution inductive displacement transducers. Through the use of DEGUSSIT AL23 (Pict. 1, p. 7), together with comprehensive thermostatic

control, the design fulfills the highest degree of precision, reproducibility and long-term stability in application temperatures of up to 1650 °C.

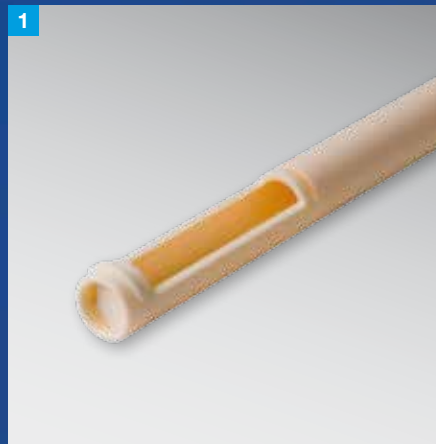
Thermogravimetry

These instruments allow thermogravimetric measurements to be carried out in corrosive, toxic and/or explosive reaction gases as well as in vapour atmospheres within a wide temperature range (up to 1600°C) and under pressu-

re. Measurement-taking in corrosive atmospheres has been made possible by a customer-patented magnetic suspension balance and by the gas-tight DEGUSSIT AL23 measurement cell tubes (Pict. 2, p. 7) in the furnace. Secure isolation of the sensitive components of the balance and the furnace from the destructive reaction atmosphere can in this way be guaranteed.

1 Tube in the field of dilatometry made of DEGUSSIT AL23

2 Tube in the field of thermogravimetry made of DEGUSSIT AL23

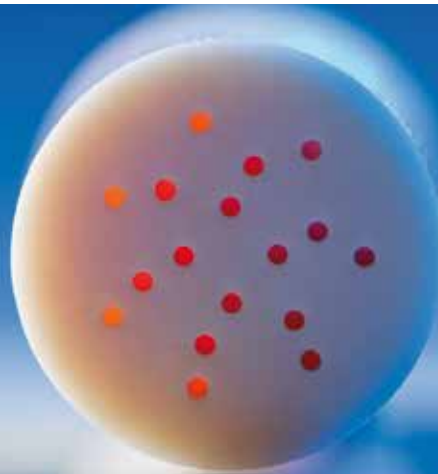


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Properties	Unit	Structural Steel (S235 JR)	DEGUSSIT AL23	DEGUSSIT AL24	DEGUSSIT AL25	DEGUSSIT FZY
Density	g/cm ³	7.85	3.4 – 3.95	3.40 – 3.60	2.80 – 3.10	5.60 – 5.80
Compressive strength	MPa	370	3500	100	300	1800
Bending strength	MPa	370	300	150	70	350
E-Module	GPa	200	380	-	-	200
Thermal expansion	10 ⁻⁶ /K	12	8.5	8.5	8.5	10.5
Thermal conductivity	W/m*K	50	30			2.5
Corrosion resistance		poor	very good	very good	very good	good
Max. temperature limit	°C	400	1950	1950	1950	1700

Glass Industry

DEGUSSIT AL23 – for advanced operational lifetime



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DEGUSSIT AL23 material has proved its worth time and again in the glass industry. Bubble tubes, used in glass melting tanks for the purpose of efficient process design, are just one example of the demanding DEGUSSIT AL23 applications.

Bubbling initiates formation of a so-called convection current ensuing from gas bubbles rising from the bottom of the melting tank. This ensures that “cold” glass from the bottom of the melting tank is transported to the surface. Refinement and homogenization of the glass melt is thus accelerated, resulting in higher melting efficiency. Creation of air bubbles and/or a complete air-bubble curtain at the end of the tank melting zone is carried out by means

of a row of bubble tubes inserted from the base of the tank by means of borings in the hearth blocks, transverse to the tank axis. These bubble tubes are made of DEGUSSIT AL23.

As the borings are small in diameter, any infiltration and cooling of the glass melt in the tube is excluded. The system is designed so that, in the case of wear on the tube tip, the bubble tubes can be inserted further into the hearth block.

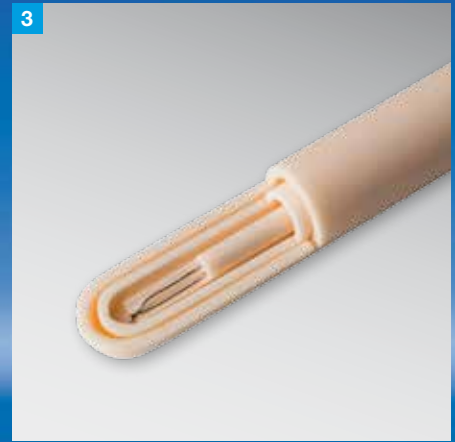
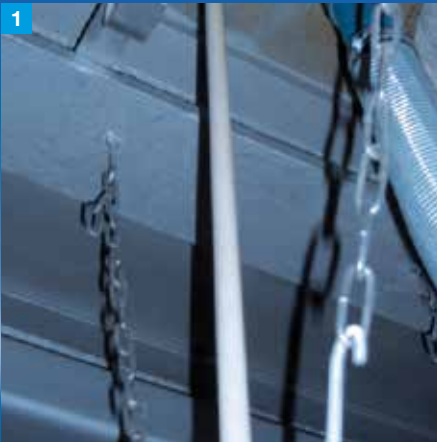
Thermocouple protection sleeves

Precise and reliable measurement technology requires highly reliable thermocouple protection sleeves (Pict. 3, p. 9), especially in the case of harsh ambient conditions. Due to their special structural properties, protection sleeves made of DEGUSSIT Ceramics can also be used at temperatures even exceeding 1800 °C.

At the same time, greater resistance to the corrosive stresses prevailing in the

1-2 Bubbling system beneath the glass melting tank

3 Thermocouple made of DEGUSSIT AL23



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tank or the melt load is achieved. In addition, there is a high degree of thermal conductivity and electrical insulation. Excellent workmanship on the closed tube tip provides an even, dense structure thus ensuring protection against cracks and leakages.

Oxygen measurement

DEGUSSIT FZY is a ZrO_2 partly stabilized with Y_2O_3 with a temperature resistance of up to 1700 °C. Originally de-

veloped for oxygen measurement for the high-temperature Lambda sensor, it is now also used as a special structural material in further applications.

Research and Development

Major research institutes and universities



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Major research institutes and universities are involved to a large extent in borderline areas of material durability. This is where the performance reserves of DEGUSSIT materials become evident.

Reaction tubes

Tubes made by FRIATEC are used in many furnaces in which there are temperatures $>1600\text{ }^{\circ}\text{C}$, as the lowest degree of deformation can be found here. Especially the reaction tubes, in which slag from fossil fuels are analyzed, are particularly exposed to thermal and chemical stresses caused by alkalis and alkaline earth metals. In part, these tubes are connected to complex analytic systems. Here, the

high level of purity of DEGUSSIT materials, especially with regard to the low SiO_2 content of 0.01%, is of special advantage in terms of operational lifetime.

Compression dies

The building materials technology department of a prestigious university is investigating new types of concrete for fireproof cladding of tunnel bores. A variety of concrete samples are

here exposed to temperatures of up to $1100\text{ }^{\circ}\text{C}$ and a pressure load of 250 kN. Compression dies made of DEGUSSIT AL23 have proven highly effective under these loads.

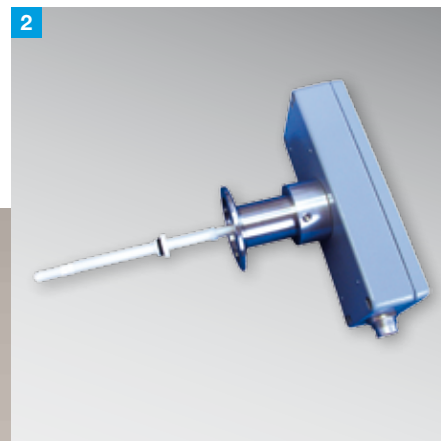
Customised solutions

In addition to our wide range of standard components we also offer our customers components manufactured to their own, individual specifications.

1 Tubes made of DEGUSSIT AL23 with analytic systems installed



2 Oxygen sensor with tubes made of DEGUSSIT FZY



3-4 Components made of DEGUSSIT AL23 under thermal and mechanical stress

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