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## Team and Application Areas

FRIALIT®-DEGUSSIT® Oxide Ceramics and an experienced Team solve your problems. The more combined demands a material has to fulfil, the more convincing become the outstanding properties of our ceramics.

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We are represented worldwide.

We would be pleased to give you the details of our foreign partners.

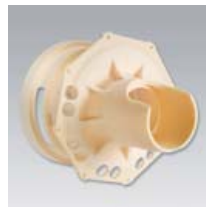
## Electrical Engineering



- electrical feedthroughs and insulating tubes for vacuum equipment
- inspection equipment for semiconductors/photovoltaics
- apparatus for research and development (accelerator technology)
- high-quality electronics
- probe technology
- sensor housings
- onshore-/offshore-technology (high pressure)



## Mechanical Engineering



- pistons for dosing pumps
- plungers for high pressure pumps
- glide rings for sealing pumps
- shaft protection sleeve
- plain bearings and roller bearings
- nozzles
- guides
- shaped parts for demanding wear resistance
- drawing cones and guides for the wire industries
- pressing dies



## High Temperature Technology



- tubes and insulating rods for protection and insulation of thermocouples, and for gas inlet and exhaust tubes
- externally-grooved tubes and special heating tubes for construction of electrically heated furnaces
- diffusion tubes for the semiconductor industry
- laboratory ware, e.g. crucibles, boats, combustion trays and plates for heat treatment and melting at high temperatures



## Surface Finishing



- fine grinding tools, e.g. whetstones, abrasive and fine files, fine grinding wheels, mounted points and bur-nishing wheels for machining metals, glass and porcelain



## Materials and Typical Applications

Material	FRIATEC Trade Name	Properties	Typical Applications
Al <sub>2</sub> O <sub>3</sub> Aluminium Oxide	<b>FRIALIT F99,7</b>	Pure Al <sub>2</sub> O <sub>3</sub> , dense, extremely resistant to wear and corrosion, very high electrical insulating properties	Matched piston/cylinder units, bearings, shafts and valve components, electrical feedthroughs, brazed ceramic to metal seals for x-ray-technology and ionic accelerators for medical technology, dielectrics for fuel cells, sensor caps
	<b>DEGUSSIT DD57</b>	Pure Al <sub>2</sub> O <sub>3</sub> , dense, red colour, wear resistant and tough, also called „sintered ruby“	Fine grinding tools for finishing hard materials for precision engineering, knife sharpener
	<b>DEGUSSIT AL23</b>	Pure Al <sub>2</sub> O <sub>3</sub> , dense, excellent thermal and electrical resistance properties, corrosion resistant, permeable for microwaves	Protection tubes for thermocouples, furnace construction parts, laboratory ware e.g. crucibles, boats and plates, reactor lining in the chemical industry, microwave-technology
	<b>DEGUSSIT AL24</b>	Pure Al <sub>2</sub> O <sub>3</sub> , slightly porous, good resistance to thermal shock, extremely good creep strength	Tubes, laboratory ware, furnace construction parts
	<b>DEGUSSIT AL25</b>	Pure Al <sub>2</sub> O <sub>3</sub> , very porous, good thermal insulation, highest resistance to thermal shock of all the Al <sub>2</sub> O <sub>3</sub> materials	Tubes, laboratory ware, furnace construction parts
Al <sub>2</sub> O <sub>3</sub> (+ZrO <sub>2</sub> ) Aluminium Oxide, fine grain stabilized	<b>FRIALIT FZT</b>	Al <sub>2</sub> O <sub>3</sub> toughened with ZrO <sub>2</sub> , dense, high strength, good resistance to thermal shock, extremely resistant to wear and corrosion, fine grain size	Vacuum plates for paper-making, flow meter tubes for chemical industry, positioning pins for automotive industry

Material	FRIATEC Trade Name	Properties	Typical Applications
ZrO <sub>2</sub> Zirkonium Oxide	<b>FRIALIT FZM</b>	ZrO <sub>2</sub> partially stabilized with MgO, dense, high strength and highly wear resistant, extremely resistant to corrosion and thermal shock	High pressure pistons, pressing dies, components for mills, ceramic isolation shells for magnetic drive centrifugal pumps, metal forming tools
	<b>FRIALIT FZY</b>	Partially stabilized with Y <sub>2</sub> O <sub>3</sub> , dense, high purity ZrO <sub>2</sub> , high temperature and corrosion resistance, ion conducting for measuring oxygen	Crucibles, heat-treatment bowls, oxygen measurement
	<b>FRIALIT FZM/K</b>	Tetragonally stabilized with Y <sub>2</sub> O <sub>3</sub> , dense, very fine grain size, highest breaking strength and wear resistance	Cutting elements, wear protection plates
SiC Silicon Carbide	<b>FRIALIT SiC 198D</b>	SSiC, highly wear resistant, good corrosion resistance, excellent sliding properties	Slide rings, bearings, slide bushings, axial sleeves
	<b>FRIALIT SiC 198</b>	SiSiC, wear resistant, excellent sliding properties, electrically conductive, high thermal conductivity	Slide rings, bearings, slide bushings, sealing discs
Si <sub>3</sub> N <sub>4</sub> Silicon Nitride	<b>FRIALIT HP 79</b>	High purity Silicon Nitride, high wear resistance, excellent bending strength, highest thermal shock resistance	Metal forming tools, rollers, plates

# Material Properties

Material	Al <sub>2</sub> O <sub>3</sub> Aluminium Oxide						
FRIATEC Trade Name	F99,7	DD57	AL23	AL24	AL25	FZT	

## Properties of Microstructure

Apparent Density	g/cm <sup>3</sup>	3,90 - 3,95	3,70 - 3,80	3,70 - 3,95	3,40 - 3,60	2,80 - 3,10	4,05 - 4,15
Open Porosity	%	0	0	0	0 - 5	20 - 30	0
Mean Grain Size	µm	10	10	10	40	70	5

## Mechanical Properties 20°C

Hardness (Knoop, 100g)	N/mm <sup>2</sup> (MPa)	23000	23000	23000	-	-	20000
Compressive Strength	N/mm <sup>2</sup> (MPa)	3500	3000	3500	1000	300	3000
Bending Strength	N/mm <sup>2</sup> (MPa)	350	300	300	150	70	460
Modulus of Elasticity	GPa	380	380	380	-	-	360

## Thermal Properties

Maximum Operating Temperature	°C	1950	1950	1950	1950	1950	1700
Specific Heat 20°C	J/kgK	850	900	850	-	-	850
Thermal Conductivity 100°C	W/mK	30	30	30	-	-	25
Expansion Coefficient 20 - 1000°C	10 <sup>-6</sup> /K	8,5	8,5	8,5	8,5	8,5	8,6

## Electrical Properties

Specific Resistance 20°C	Ω cm	10 <sup>15</sup>	10 <sup>14</sup>	10 <sup>14</sup>	-	-	-
Specific Resistance 500°C	Ω cm	10 <sup>11</sup>	10 <sup>10</sup>	10 <sup>10</sup>	-	-	-
Specific Resistance 1000°C	Ω cm	10 <sup>7</sup>	10 <sup>7</sup>	10 <sup>7</sup>	-	-	-

Material	ZrO <sub>2</sub> Zirkonium Oxide			Non-Oxides		
FRIATEC Trade Name	FZM	FZY	FZM/K	SiC 198D	SiC 198	HP 79

#### Properties of Microstructure

Apparent Density	g/cm <sup>3</sup>	5,70 - 5,80	5,50 - 5,80	6,00 - 6,10	3,15	3,1	3,25
Open Porosity	%	0	0	0	< 1	< 1	< 1
Mean Grain Size	µm	50	50	0,5	10	-	10

#### Mechanical Properties 20°C

Hardness (Knoop 100g)	N/mm <sup>2</sup> (MPa)	16000	17000	18000	26000	-	16000
Compressive Strength	N/mm <sup>2</sup> (MPa)	2000	2000	2200	2500	1000	3000
Bending Strength	N/mm <sup>2</sup> (MPa)	500	400	800	400	300	850
Modulus of Elasticity	GPa	185	200	200	400	330	320

#### Thermal Properties

Maximum Operating Temperature	°C	900	1500	1200	1650 - 1900	1400	1200
Specific Heat 20°C	J/kgK	400	400	400	1000	900	800
Thermal Conductivity 100°C	W/mK	2,5	2,5	2,5	100	130	30
Expansion Coefficient 20 - 1000°C	10 <sup>-6</sup> /K	11,1	11,2	10,8	4,5	4,4	3,2

#### Electrical Properties

Specific Resistance 20°C	Ω cm	10 <sup>10</sup>	10 <sup>10</sup>	10 <sup>10</sup>	10 <sup>-1</sup>	0,2	10 <sup>10</sup>
Specific Resistance 500°C	Ω cm	10 <sup>4</sup>	5 * 10 <sup>3</sup>	10 <sup>2</sup>	-	-	-
Specific Resistance 1000°C	Ω cm	25	15	-	-	0,005	10 <sup>7</sup>

The data indicated in this table is in line with the introductory German Industrial Standard DIN 40685 and relates to the specimens from which it was obtained

and is not unconditionally applicable to other forms of the same material. The data must, therefore, be regarded as indicative only.

**FRIALIT®-DEGUSSIT® Oxide Ceramics for:**

Electrical Engineering

High Temperature Technology

Mechanical Engineering

Surface Finishing



## Competence plus Responsibility

Our customers rightly expect first-class performance with lasting value.

Besides the competence to achieve this, we also undertake the responsibility for it.

Please ask for the evidence: FRIALIT®-DEGUSSIT® is the technological and market leader in ceramic materials for the 21st Century.

FRIATEC AG

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