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LITHOZ®

Manufacture the future.

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MATERIAL OVERVIEW
LCM TECHNOLOGY

LITHOZ | 3D Printing Materials for Ceramic Innovation

MATERIALS TAILORED FOR YOUR APPLICATION

Lithoz is always working on **developing exciting new materials**. We are ready for your material requests and will listen carefully to any **specific needs** in terms of properties or usability requirements. Existing materials are also constantly being worked upon and improved in order to allow for more **efficient handling** in CeraFab printers, with **optimized processability** being an area of particular importance to us.

HIGH-QUALITY MATERIALS

Lithoz develops materials for the **LCM process**, with their expert ceramists, chemists, material scientists and process developers working together to create **ceramic slurries** which are **specifically optimized** not only for our CeraFab 3D printers, but also to match our customers' needs. These materials surpass the **high standards of quality** needed for **industrial, medical** and **dental** applications.

Using strict development processes, detailed **documentation** and active exchanges of information with **renowned research institutes** such as FGK -Glas/Keramik- and the Fraunhofer IKTS, our materials are **trusted** by top manufacturers worldwide and are **ISO 9001:2015 certified**, while our **wide range of available materials** means there is sure to be one **perfectly suited** for your requirements.

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ZERTIFIKAT NR. 20100151450154
TÜV AUSTRIA CERT GMBH

LITHOZ | Development Materials

Lithoz is constantly working on research projects involving new and innovative materials.

ALUMINIUM NITRIDE

Aluminium nitride is the perfect **high-performance ceramic material** for **thermal applications**. The density and thermal conductivity of additively manufactured aluminium nitride components matches that of conventionally produced parts, while properties including a **thermal expansion coefficient** similar to silicone, as well as high mechanical and thermal **stability**, make it a desirable material for **industrial** applications.

PIEZOCERAMICS

Piezoelectric components are key elements in a variety of **electrical** components, sensors and actuators. Lithoz works with the most widely used piezoceramics, such as **lead zirconate titanate** (PZT), but is also actively working on the development of **lead-free alternatives** such as barium titanate or potassium sodium niobate. Novel piezoelectric designs, only achievable using AM technology, allow for an **increase of power** and/or enable **miniaturization**.

HIGH-DIELECTRIC CERAMICS

These materials exhibit extremely high **permittivity** and **low loss factors**, making them ideal candidates for antennas, filters or resonator components in **high-frequency applications** such as 5G wireless communication systems or telecommunications.

MEDICAL-GRADE MATERIALS

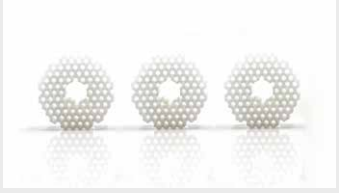
Lithoz has now developed medical-grade materials for use in **healthcare** and **dentistry**. **Silicon nitride** is perfect for use in the medical engineering of permanent **implants** due to its osseointegrative potential and **anti-infective** properties. **Zirconia**, as a **biocompatible** material, is well-suited for manufacturing medical and dental implants.

TRANSPARENT CERAMICS

Transparent ceramics offer significantly higher properties of **hardness** and **strength** compared to conventional glass, making them perfect for applications where glass is unusable due to its (thermo)mechanical limits. Applications include jewellery and medicine (particularly in dentistry), but they are also used in the **electro-optical field** for applications such as optical switches, laser amplifiers and lenses, to name just a few.

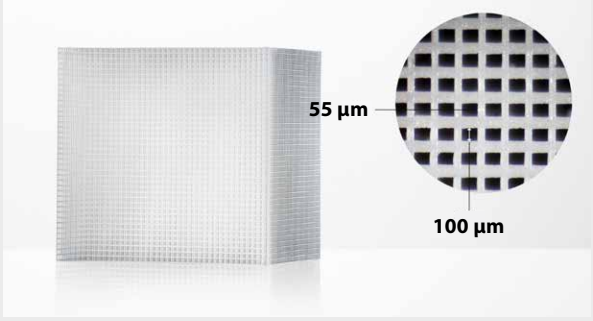
BROADENING YOUR RANGE OF APPLICATIONS

ZIRCONIA-TOUGHENED ALUMINA
Zirconia-toughened alumina (ZTA) is a mixed ceramic which combines the properties of zirconia and alumina. In order to **increase fracture toughness**, alumina is reinforced with zirconia to increase the bending strength to 620 MPa. The result is zirconia-toughened alumina, a material with the **hardness of alumina** and the **increased toughness, strength** and stiffness of **zirconia**. **ZTA10** (10 vol% zirconia) and **ZTA20** have already been successfully processed, and customer-specific mixing ratios can also be produced if desired.



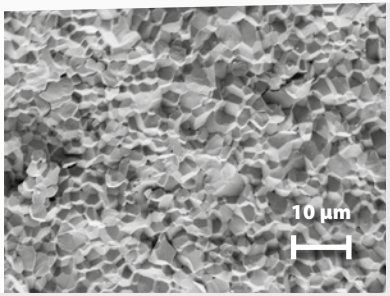
LITHABONE TCP 380 – TRICALCIUM PHOSPHATE
This tricalcium phosphate material was developed specially for manufacturing parts with **high wall thicknesses**, high **density** and improved mechanical properties using the LCM process. **Wall thicknesses** of **more than 6mm** can be produced, and this material has an impressive **3-point bending strength** of **more than 100 MPa**.

LITHALOX 360 – ALUMINA
LithaLox 360 is a further development of the **industry-trusted** alumina LithaLox 350. With an **optimized binder** that enables **high-resolution features**, it is easy to manufacture even the **thinnest** of **channels** and fine bores, not only in larger but also smaller components. Using this material, **channel openings** of **less** than **200 µm** and **bridges smaller** than **100 µm** are possible.



LITHOZ | **LithaLox HP 500 | 350**
Alumina

TECHNICAL DATA



ALUMINA contains one of the most important oxide ceramic materials and is characterized by its desirable properties, including **high hardness, corrosion** and **temperature resistance**. Components made of alumina are **electrically insulating** and **puncture-proof**, making them suitable for a wide range of applications such as substrates in the **electronics industry** among many others. Alumina is also used in **medical engineering** for manufacturing permanent implants or devices due to being biocompatible.

LITHALOX HP 500 contains a **high-purity** aluminum oxide **(99.99 %)** material and is characterized by its **high density**, a favorable **fourpoint bending strength** and exceptionally smooth **surface quality**.

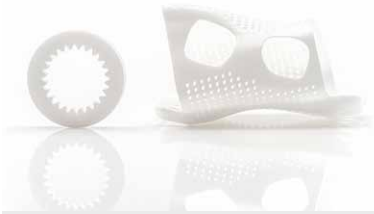
LITHALOX 350 contains a **high-purity** aluminum oxide **(99.8 %)** mixture with outstanding material properties. It is specially developed for manufacturing **highly complex components** with small channels and holes.

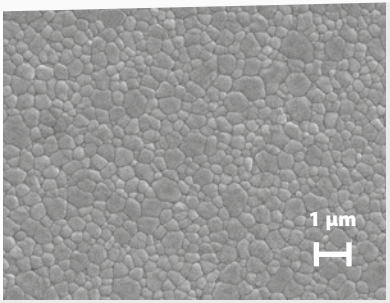
POWDER	HP 500	350
Purity [%]	99.99	99.8
SLURRY		
Solids loading [vol%]	49	
Dynamic viscosity[1] [Pa·s]	8	6
SINTERED CERAMIC		
Theoretical density [g/cm^3]	3.99	
Relative density [%]	99.4	98.4
Four-point bending strength [MPa]	430	400
Surface roughness R_a [µm]	0.4	0.9
Relative permittivity (measured at 7.5 GHz)	9.9	9.5
Dielectric loss tanδ (measured at 7.5 GHz)	9 x 10^{-5}	8 x 10^{-5}
TYPICAL PROPERTIES[2]		
Young's modulus [GPa]	300	
Fracture toughness [MPa·m$^{1/2}$]	4 – 5	
Hardness HV10	1450	
Max. working temperature [°C]	1650	
Coefficient of thermal expansion [ppm/K]	7 – 8	
Thermal conductivity [W/(m·K)]	37	
Specific electrical resistivity [Ω·cm]	≈ 10^{14}	

[1] Value was determined at a constant shear-rate of 50 s^{-1} at 20 °C.
[2] Typical values for this type of ceramic. These values have not been determined for LithaLox 350.

LITHOZ | **LithaCon 3Y 210**
Zirconia

TECHNICAL DATA





ZIRCONIA is used for applications with **extreme demands** on the material. High-end **metal forming**, valves, bearings and **cutting tools** are some of the applications which benefit from the mechanical properties of zirconia. The biocompatibility of zirconia facilitates its use in **medical** applications, such as dental applications and as part of permanent **implants**.

LITHACON 3Y 210 contains a **3 mol%** yttria stabilized zirconia material. Some of the mechanical highlights of these materials are their **excellent flexural strength** (> 1000 MPa), **fracture toughness**, resistance to abrasion and **thermal shock resistance**. These properties, in combination with its **chemical resistance** even at elevated temperatures, make zirconia the perfect material for structural elements. LithaCon 3Y 210 also has a **low viscosity** which makes it **easy to process** in the CeraFab printers and to clean. This suspension was tailored for the manufacture of **delicate** and **complex parts**.

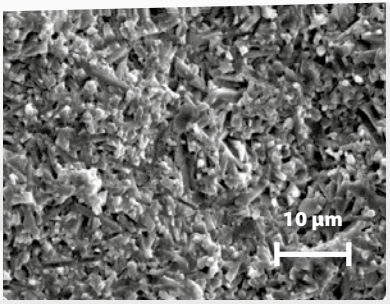
SLURRY	
Solids loading [vol%]	48
Dynamic viscosity[1] [Pa·s]	15
SINTERED CERAMIC	
Theoretical density [g/cm^3]	6.088
Relative density [%]	99.4
Relative permittivity (measured at 3 GHz)	27.6
Dielectric loss tanδ (measured at 3 GHz)	2.5 x 10^{-3}
Four-point bending strength [MPa]	940
TYPICAL PROPERTIES[2]	
Young's modulus [GPa]	205
Compressive strength [MPa]	2300
Fracture toughness [MPa·m1/2]	10 – 13
Hardness HV10	1250
Max. working temperature [°C]	1500
Coefficient of thermal expansion [ppm/K]	10
Thermal conductivity [W/(m·K)]	2.5 – 3.0
Specific electrical resistivity [Ω·cm]	> 10^{10}

[1] Value was determined at a constant shear-rate of 50 s^{-1} at 20 °C.
[2] Typical values for this type of ceramic. These have not been determined for LithaCon 3Y 210 and 3Y 230.

LITHOZ®

LithaNit 770
Silicon nitride

TECHNICAL DATA



SILICON NITRIDE is a Beta-SiAlON type ceramic. It exhibits superior material properties such as **high strength**, high **toughness**, **thermal shock resistance** and good **chemical resistance** to corrosion by many acids and alkalis. It is well suited to applications in the **medical** field and those which require high **thermal resistance**, as well as for use as cutting tools.

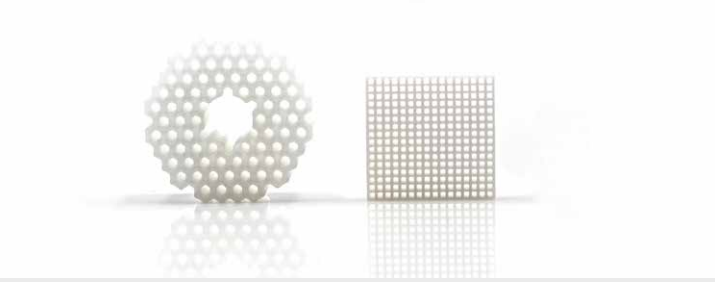
LITHANIT 770 has a wide range of applications including insulators, springs, **impellers** and more. Furthermore, it can be used for the **medical** engineering of permanent **implants** due to its osseointegrative potential and **anti-infective** properties.

SLURRY	
Solids loading [vol%]	40
Dynamic viscosity[1] [Pa·s]	3 – 6
SINTERED CERAMIC	
Theoretical density [g/cm^3]	3.24
Relative density [%]	99.8
Biaxial flexural strength [MPa]	760
Hardness HV10	1500
Surface roughness R_a [µm]	0.7
Cytotoxicity	Not cytotoxic according to ISO 10993-5
Skin irritability	No skin irritation according to ISO 10993-10
Thermal conductivity [W/(m·K)]	28
Specific electrical resistivity [Ω·cm]	1200
TYPICAL PROPERTIES[2]	
Young's modulus [GPa]	290 – 300
Compressive strength [MPa]	> 3500
Fracture toughness [MPa·m$^{1/2}$]	7
Max. working temperature [°C]	1200
Coefficient of thermal expansion [ppm/K]	3

[1] Value was determined at a constant shear-rate of 50 s^{-1} at 20 °C.
[2] Typical values for this type of ceramic. These have not been determined for LithaNit 770.

LITHOZ | **LithaBone TCP 300**
Tricalcium phosphate

TECHNICAL DATA



TRICALCIUM PHOSPHATE (TCP) exhibits excellent **biocompatibility**, **bioresorbability** and **osteoconductivity**, and is therefore a well-established material for **bone replacement** in regenerative medicine. Due to its properties, it is possible to manufacture **patient-specific resorbable implants** with defined pore structures and geometries using this material. During the healing phase, these implants will be resorbed by the body and replaced by native bone tissue, meaning that a second surgery for the removal of the implant is not necessary.

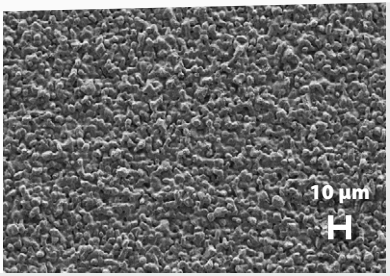
LITHABONE TCP 300 contains a beta-tricalcium phosphate (ß-TCP) based ceramic. By varying the sintering process, relative **densities** of **up to 98 %** can be achieved. Lithoz aims to support the validation process of your medical product in the best way, and therefore only **ASTM F1088 - 04a certified** (suitable for human implants) TCP powder is used in LithaBone TCP 300. Sintered parts made from LithaBone TCP 300 are proven not to be cytotoxic according to the ISO 10993-5:2009 standard.

POWDER	
Purity [%]	≥ 95
Heavy metal content [ppm]	Max. 50
Complies with the specification for β-tricalcium phosphate as implant material (ASTM F1088 - 04a)	Yes
SLURRY	
Solids loading [vol%]	47
Dynamic viscosity[1] [Pa·s]	6 – 12
SINTERED CERAMIC	
Theoretical density [g/cm^3]	3.07
Relative density [%]	98.0
Cytotoxicity	Not cytotoxic according to ISO 10993 - 5
Skin irritability	No skin irritation according to ISO 10993 -10

[1] Value was determined at a constant shear-rate of 50 s^{-1} at 20 °C.

LITHOZ | LithaBone HA 400 Hydroxyapatite

TECHNICAL DATA



HYDROXYAPATITE (HA) is a naturally occurring mineral that forms the main component of bones. HA possesses excellent **biocompatibility** and osteoconductivity and has a number of potential applications, such as a **bone substitute**. In comparison to tricalcium phosphate, HA takes far more time to be absorbed into the body, thereby giving the body **more time to heal**. HA is used in patient-specific, bioresorbable **implants** with defined pore structures and geometries, which are reabsorbed by the body and replaced by native bone tissue so that no removal of the implant after the healing process is needed.

LITHABONE HA 400 contains a ceramic material based upon hydroxyapatite (HA). With a relative **density of 85 %** and a corresponding **porosity of 15 %**, LithaBone HA 400 is perfect for **bioresorbable** applications. Lithoz exclusively uses HA powder certified according to **ASTM standard F1185-03** (suitable for human implants) to best support you throughout the validation process of your medical device. Sintered parts made of LithaBone HA 400 are not cytotoxic according to ISO 10993-5:2009 standard.

POWDER	
Purity [%]	≥ 95
Heavy metal content [ppm]	Max. 50
Complies with the specification for hydroxyapatite as implant material (ASTM F1185 - 03)	Yes
SLURRY	
Solids loading [vol%]	46
Dynamic viscosity[1] [Pa · s]	5 – 10
SINTERED CERAMIC	
Theoretical density [g/cm³]	3.16
Relative density [%]	85.0
Cytotoxicity	Not cytotoxic according to ISO 10993 - 5

[1] Value was determined at a constant shear-rate of 50 s^{-1} at 20 °C.

LITHOZ | **LithaCore 450**
Silica-based

TECHNICAL DATA

LITHACORE 450 has been developing based on a mixture of **silica** with **alumina** and **zircon**. It is used for the production of **casting cores** for investment casting. Typical applications include single crystal casting of **turbine blades** and **ceramic shell casting**. The requirements for producing new designs of multi-vane, complex feature cores go beyond the limits of consistently successful mold and tool-based processes.

Our **high-quality** materials facilitate the production of increasingly complex designs, with casting cores of sizes up to **500 mm** able to be manufactured. Sintered ceramic cores made from LithaCore 450 have very low thermal dilatation up to **1500 °C**, high porosity, outstanding surface quality and a very good leachability.

SLURRY	
Solids loading [vol%]	63
Dynamic viscosity[1] [Pa·s]	45
SINTERED CERAMIC	
Theoretical density [g/cm^3]	2.44
Relative density [%]	72.0
Three-point bending strength [MPa]	10
Three-point bending strength (impregnated) [MPa]	18
Surface roughness R_a [µm]	< 3
Max. grain size sintered [µm]	100
Cristobalite content [wt%]	20 – 40
Leachability	Very good
Max. working temperature [°C]	1575
Dilatation @ 1000°C [%]	< 0.2
Dilatation @ 1500°C [%]	< 0.5

[1] *Value was determined at a constant shear-rate of 50 s^{-1} at 20 °C.*

CUSTOM MATERIALS FOR YOUR INNOVATIONS

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"Lithoz's expertise in ceramic 3D printing supports every aspect of advanced ceramic material development, providing cross-industry solutions for new product development and production processes."

Professor Alexander Michaelis, of the Fraunhofer Institute for Ceramic Technologies and Systems IKTS

GOT YOUR EYE ON A DIFFERENT MATERIAL?

With **10 years of experience** in the ceramic 3D printing field, Lithoz is a valuable and reliable **partner** in both industry and research and will support you in your projects during the entire process.

Get in contact with us to find out more about how we can develop **your ideal material**!

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