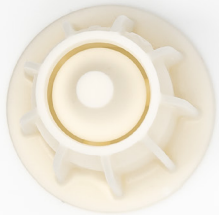
LITHOZ®

We are ceramic 3D printing.

Material Overview

LCM Technology

www.lithoz.com





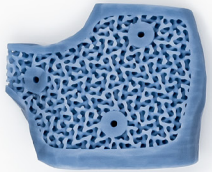
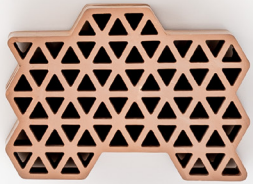



Table of Contents

05 **High-performance materials tailored to your application**

06 **Pre-series ceramic materials**
06 High-Dielectric Ceramics
06 Piezoceramics
07 Yttria
07 Transparent Ceramics
08 LithaGlass powered by Glassomer
09 Lithium Disilicate

10 **Materials**
11 Aluminium Nitride
12 LithaLox ZTA 1080 - Zirconia-toughened alumina
13 LithaCon ATZ 980 - Alumina-toughened zirconia
14 LithaLox 350 | 360 - Alumina
16 LithaLox HP 500 - Alumina
18 LithaCon 3Y 210 | 3Y 230 - Zirconia
20 LithaCore 450 - Silica-based
22 LithaNit 782 - Silicon nitride
24 LithaBone TCP 300 - Tricalcium phosphate
26 LithaBone HA 480 - Hydroxylapatite

28 **Contact**

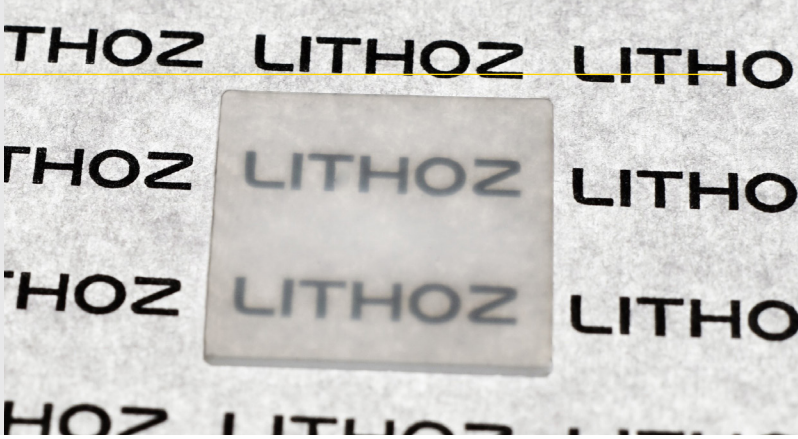
High-performance materials tailored to your application

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 produced under a ISO 9001:2015 certified quality management system. Our wide range of available materials means there is sure to be one perfectly suited for your requirements.

Lithoz materials are produced in a cleanroom Environment

TÜV AUSTRIA
ZERTIFIZIERT
EN ISO 9001
ZERTIFIKAT NR. 20100151450154
TÜV AUSTRIA CERT GMBH



High-Dielectric Ceramics

Diverse dielectric ceramic materials exhibit extremely high permittivity and low loss factors, making them the ideal candidates for antennas, filters or resonator components. Such parts are commonly used in high-frequency applications, such as 5G wireless communication systems or telecommunications. Using powerful Lithoz LCM technology, it is currently possible to process a range of different dielectric materials with varying permittivities (dieletric constants) between 20 and 60. These materials are opening the door to groundbreaking new applications and innovative ideas.

Piezoceramics

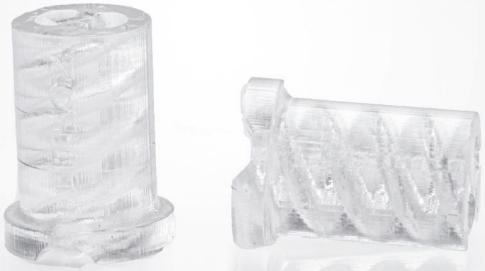
Piezoelectric components are key elements in a variety of electrical components, sensors and actuators. Lithoz works with the most widely used piezoceramics, such as lead zirconate titanate (PZT), but is also actively developing lead-free alternatives such as barium titanate or potassium sodium niobate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

Yttria

Yttria (yttrium oxide, Y_2O_3) has many potential applications in the technical ceramics field. Due to its high corrosion resistance in extreme environments, components made of yttria find use in plasma-etching in the semiconductor industry. Additively manufactured dense yttria components can potentially replace porous yttria-coated parts in the semiconductor industry due to their superior stability in plasma environment. It also finds application as an aerospace and glass material for extreme conditions. Transparent yttria is also a prospective material for solid state lasers.

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.



JOINTLY DEVELOPED WITH ivoclar

LithaGlass

powered by Glassomer

After intensive cooperation with glass manufacturer Glassomer, Lithoz has launched the new LithaGlass material. As a slurry with a base of quartz glass, the fact that it can be 3D-printed makes LithaGlass a ground-breaking new achievement, combining the design freedom of 3D printing with the desirable properties of high-performance fused silica glass – such as mechanical stability and high thermal and chemical resistance, as well as low thermal expansion and a resulting high resistance to thermal shock.

Lithium Disilicate

Lithium disilicate is widely used for manufacturing dental restorations where aesthetics are particularly important. With 3D printing constantly evolving, it will be possible via additive manufacturing to produce ceramic restorations with similar properties to IPS e.max lithium disilicate products.

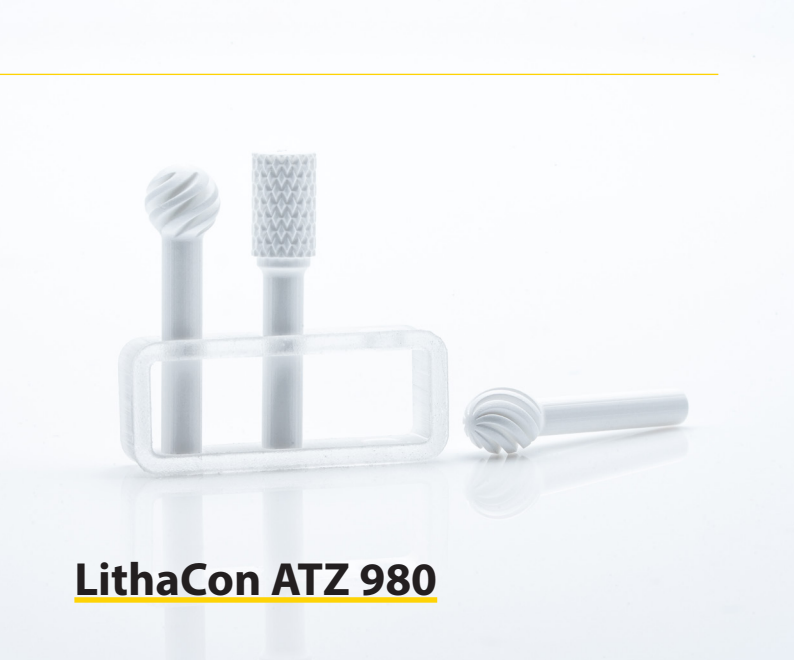
Aluminium Nitride

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 silicon, as well as high mechanical and thermal stability, make it a desirable material for industrial applications and semiconductors.

LithaLox ZTA 1080

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. Furthermore, mixtures with lower amounts of zirconia retain the electrical insulation capacity of alumina.

ZTA10 (10 vol% zirconia) and ZTA20 (20 vol% zirconia) have already been successfully processed, and customer-specific mixing ratios can also be produced if desired.



LithaCon ATZ 980

Alumina-toughened zirconia (ATZ) combines the best material properties of alumina and zirconia. This results in high levels of strength, hardness, fracture toughness, as well as good biocompatibility, chemical inertness and abrasion resistance, making ATZ components perfectly suited to medical applications, such as permanent implants in dentistry and orthopedics, as well as other high-wear applications.

The ATZ powder used by Lithoz has around 20 wt% alumina and 80 wt% zirconia. Thanks to remarkably high wall thicknesses up to 20 mm and a characteristic strength of 750 MPa (3PB, as fired), complex and highly precise 3D-printed ATZ parts can now be produced using LithaCon ATZ 980.

LithaLox 350 | 360

Alumina

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.

LITHALOX 350 contains a high-purity aluminum oxide (99.8 %) mixture with outstanding material properties. As a very flexible and adaptable material, it is an all-rounder specially developed for rapidly manufacturing highly complex components with small channels and holes.

LITHALOX 360 has been specially optimized for designing even higher resolutions and precise structures thanks to a modified binder formulation. With this aluminum oxide, even the finest of channels, lattice structures and holes in miniaturized components can be achieved, such as channel openings of less than 200 µm and struts smaller than 100 µm.

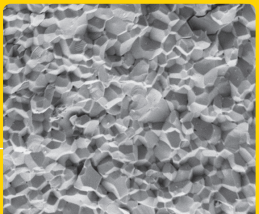
POWDER

Purity [%]	99.8

SINTERED CERAMIC

Theoretical density [g/cm^3]	3.985
Relative density [%]	98.4
Three-point bending strength [MPa]	–
Four-point bending strength [MPa]	400
Surface roughness R_a [µm]	0.9
Relative permittivity (measured at 7.5 GHz)	9.5
Dielectric loss tanδ (measured at 7.5 GHz)	9 x 10^{-5}
Fracture toughness [MPa·m$^{1/2}$]	3
Hardness HV10	1550
Coefficient of thermal expansion [ppm/K]	7 – 8
Young's modulus [GPa]	380
Max. working temperature [°C]	1650
Thermal conductivity [W/(m·K)]	29
Specific electrical resistivity [Ω·cm]	≈ 10^{14}

10 µm



LithaLox HP 500

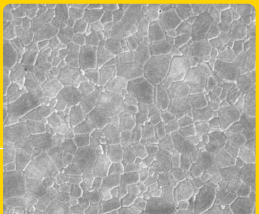
Alumina

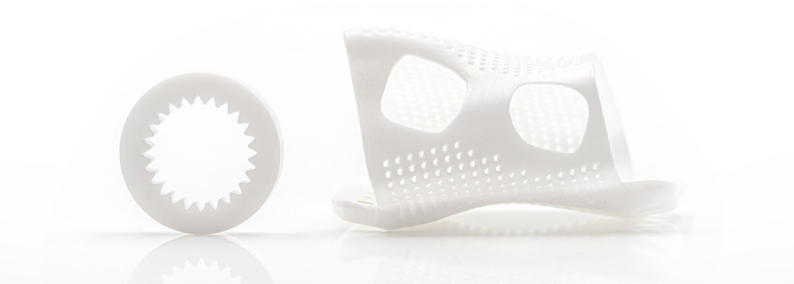
ALUMINA contains one of the most important oxide ceramic materials and is characterized by its desirable properties, including high hardness, corrosion and temperature resistance. Components made of alumina are electrically insulating and puncture-proof, making them suitable for a wide range of applications 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 four-point bending strength and exceptionally smooth surface quality.

POWDER	
Purity [%]	99.99

SINTERED CERAMIC	
Theoretical density [g/cm^3]	3.985
Relative density [%]	99.4
Four-point bending strength [MPa]	430
Surface roughness R_a [µm]	0.4
Relative permittivity (measured at 7.5 GHz)	9.9
Dielectric loss tanδ (measured at 7.5 GHz)	9 x 10^{-5}
Fracture toughness [MPa·m$^{1/2}$]	4 – 5
Hardness HV10	1550
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}





LithaCon 3Y 210 | 3Y 230

Zirconia

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 for dental implants or for orthopaedic implants.

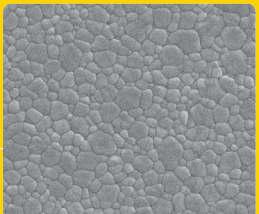
LITHACON 3Y 210 AND 3Y 230 contain a 3 mol% yttria stabilized zirconia material. Some of the mechanical highlights of these materials are their excellent flexural strength (> 1000 MPa), fracture toughness, resistance to abrasion and thermal shock and chemical resistance, making zirconia perfect for structural elements.

LITHACON 3Y 210, with its higher green stiffness, is specifically tailored to the production of very delicate and complex parts, while the different binder composition of LithaCon 3Y 230 makes it well suited to more flexible and bulkier components. Both LithaCon products also have a low viscosity which makes it easy to process in the CeraFab printers and to clean.

SINTERED CERAMIC

Theoretical density [g/cm^3]	6.088
Relative density [%]	99.4
Three-point bending strength [MPa]	1000
Four-point bending strength [MPa]*	930
Weibull modulus	13
Relative permittivity (measured at 3 GHz)	29
Dielectric loss tanδ (measured at 3 GHz)	0.001
Young's modulus [GPa]	205–210
Compressive strength [MPa]	2000–2500
Fracture toughness [MPa·m$^{1/2}$]	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^{13}

** Not yet measured for LithaCon 3Y 230.*



LithaCore 450

Silica-based

LITHACORE 450 has been developed 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.

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

LithaNit 782

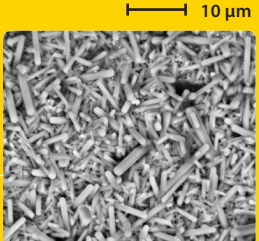
Silicon Nitride

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 782 has a wide range of applications including insulators, springs or turbine wheels. Furthermore, due to its osseointegrative and anti-bacterial properties, LithaNit 782 has a broad variety of uses in the medical field – for example, for permanent implants or surgical tools.

SINTERED CERAMIC

Theoretical density [g/cm^3]	3.23
Relative density [%]	> 99.8
Biaxial flexural strength [MPa]	760
Hardness HV10	1500
Surface roughness R_a [µm]	0.7
Thermal conductivity [W/(m·K)]	28
Specific electrical resistivity [Ω·cm]	1200
Biocompatibility	Not cytotoxic according to ISO 10993-5



LithaBone TCP 300

Tricalcium Phosphate

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.

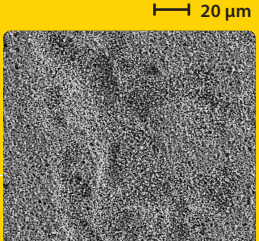
LITHABONE TCP 300 contains a beta-tricalcium phosphate (ß-TCP) based ceramic. By varying the sintering process, relative densities of up to 98 % can be achieved. Lithoz aims to support the validation process of your medical product in the best way, and therefore only ASTM F1088 certified (suitable for 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 standard ISO 10993-5.

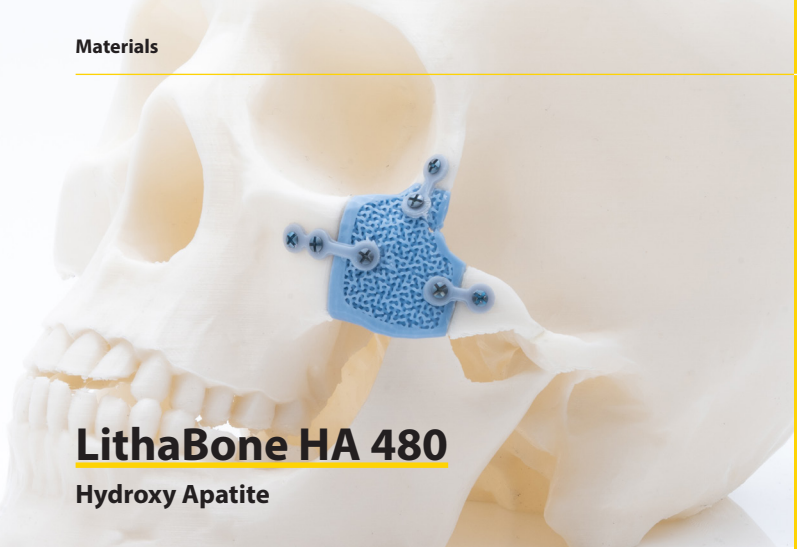
POWDER

Purity [%]	≥ 95
Heavy metal content [ppm]	Max. 50
Complies with the specification for β-tricalcium phosphate as implant material (ASTM F1088)	Yes

SINTERED CERAMIC

Theoretical density [g/cm³]	3.07
Relative density [%]	98.0
Biocompatibility	Not cytotoxic according to ISO 10993 - 5





LithaBone HA 480

Hydroxy Apatite

HYDROXY APATITE (HA) is a naturally occurring mineral that forms the main component of bones. HA has excellent biocompatibility and osteoconductivity and is therefore used in bioresorbable implants with well-defined, porous and patient-specific geometries. Once inside the body, bone cells will grow through it, gradually resorbing the material. This means no removal of the implant is necessary and ensures surgeries are less expensive and traumatic. Other bone cells will simultaneously build up newly formed natural bone, which is especially necessary in critical-sized bone defects too large to heal without bone substitute material. When compared to other such materials, HA takes far longer to be resorbed, thereby giving the body more time to heal.

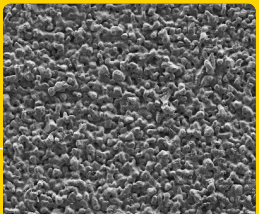
LITHABONE HA 480 is a 3D-printable hydroxy apatite that has been specially developed for the production of patient-specific ceramic implants. It is giving the user a broad range of geometric flexibility, an adjustable microporosity, best mechanical properties and easy handling. Lithoz uses only HA powders that are compliant with ASTM F1185.

POWDER

Purity [%]	≥ 95
Heavy metal content [ppm]	Max. 50
Complies with ASTM F1185	Yes

SINTERED CERAMIC

Theoretical density [g/cm³]	3.16
Relative density [%]	[92 – 98]
Biocompatibility	Not cytotoxic according to ISO 10993 - 5



Let's rewrite the rules of ceramics!

To us, pushing the limits of ceramics ever further is not just a business. We promise to always deliver the highest quality in ceramic 3D printing technology and to be your partner in driving ceramic innovation forward. Let's manufacture the future. Together.

> *"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 over 10 years 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!

CONTACT LITHOZ GMBH

Mollardgasse 85a / 2 / 64 – 69 | 1060 Vienna • Austria
Email: sales@lithoz.com | Phone: +43 1 9346612 200