



# Ceramics for 3D printing

Typical characteristics of ceramic  
materials after sintering

## Important information - Non-contractual data

The technical data and values presented in this document are provided for information purposes only.

They are based on tests performed using 3DCeram machines and internal processes. Results may vary depending on specific manufacturing conditions, particularly the debinding and sintering temperatures and profiles, as well as the geometry of the printed parts. These data do not constitute a contractual commitment and do not engage the responsibility of 3DCeram. It is the user's responsibility to validate the final properties within the context of their own process and intended application.

### **Regarding medical applications:**

The use of these materials for medical purposes is subject to the regulations in force in each country. Regulations and standards may vary from one country to another. It is the user's responsibility to ensure that all materials and parts comply with applicable regulatory requirements and to obtain all necessary approvals from the relevant authorities prior to any use in a medical device.

## Summary

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# Alumina

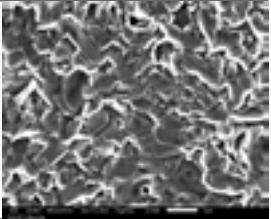
## Properties

- Good mechanical strength
- Good thermal conductivity
- High electrical resistivity
- High hardness
- Good wear resistance
- Chemically inert

## Application

- Electrical insulators
- Laboratory devices
- Telecommunication equipment
- Electronical devices
- Spatial
- Optical instruments



| Microstructure             |                      | Values                                                                              |
|----------------------------|----------------------|-------------------------------------------------------------------------------------|
| Density                    | g/cm <sup>3</sup>    | 3,9                                                                                 |
| SEM picture                |                      |  |
| Mechanical properties      |                      |                                                                                     |
| 4-pt bending strength      | MPa                  | 300-350                                                                             |
| Weibull modulus            |                      | 14.9                                                                                |
| Theoretical young modulus  | GPa                  | 300                                                                                 |
| Vickers hardness           | GPa                  | 16.4                                                                                |
| Fracture toughness         | MPa.m <sup>1/2</sup> | 4                                                                                   |
| Thermal properties         |                      |                                                                                     |
| Thermal conductivity at RT | W/m.K                | 23.3                                                                                |
| Thermal expansion coef.    | at -50°C             | 3.74                                                                                |
|                            | at 20°C              | 4.98                                                                                |
|                            | at 60°C              | 5.51                                                                                |

# Zirconia 3Y

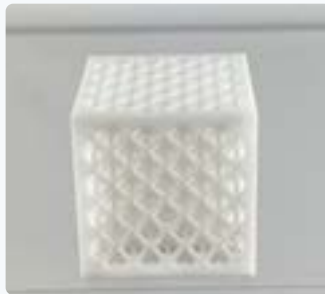
*Thermo structural applications*

## Properties

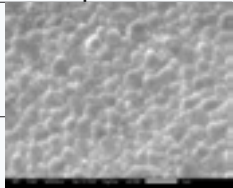
- Excellent mechanical properties
- Chemical inertness
- High hardness

## Application

- Dental & orthopedic implants
- Cutting tools
- Luxury (jewels, watches, etc...)
- Fuel cells (SOFC, SOEC)
- Fiber optic connector
- Electronic equipment



Available on C101 EASY, C900 FLEX,  
C1000 FLEXMATIC

| Microstructure             |                                                                                     | Values                            |      |
|----------------------------|-------------------------------------------------------------------------------------|-----------------------------------|------|
| Densification rate         | %                                                                                   | 99.5                              |      |
| Density                    | g/cm <sup>3</sup>                                                                   | 5.95                              |      |
| SEM picture                |  |                                   |      |
| Mechanical properties      |                                                                                     |                                   |      |
| 4-pt bending strength      | MPa                                                                                 | 950                               |      |
| Weibull modulus            |                                                                                     | 9                                 |      |
| Theoretical young modulus  | GPa                                                                                 | 200                               |      |
| Vickers hardness           | GPa                                                                                 | 12.6                              |      |
| Shear modulus              | GPa                                                                                 | 79.8                              |      |
| Compressive strength       | MPa                                                                                 | 2070                              |      |
| Thermal properties         |                                                                                     |                                   |      |
| Thermal conductivity at RT | W/m.K                                                                               | 3.3                               |      |
| Thermal expansion coef.    | at -50°C                                                                            | 10 <sup>-6</sup> .K <sup>-1</sup> | 8.59 |
|                            | at 20°C                                                                             |                                   | 9.10 |
|                            | at 60°C                                                                             |                                   | 9.34 |

*Non contractual data for reference only - V17092025*

# Zirconia 8Y

## Properties

- High oxygen ion conductivity
- High aging resistance
- High thermal stability

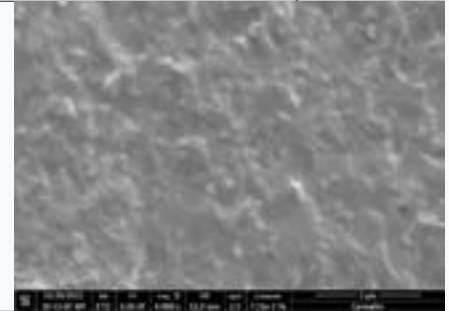
## Application

- Fuel cell (SOEC, SOFC, Electrolyte)
- Oxygen sensor
- Thermal applications



| Microstructure     |                   | Values |
|--------------------|-------------------|--------|
| Densification rate | %                 | 99     |
| Density            | g/cm <sup>3</sup> | 5.79   |

SEM picture



## General properties

Ionic conductivity

$$\sigma T = 17 \text{ S.cm}^{-1}.\text{K}$$

$$(T = 800^{\circ}\text{C})$$

$$\sigma T = 3 \text{ S.cm}^{-1}.\text{K}$$

$$(T = 600^{\circ}\text{C})$$

4-pt bending strength      MPa      300

# Hydroxyapatite

## Properties

- Biocompatibility
- Excellent bioactivity
- Good osseointegration

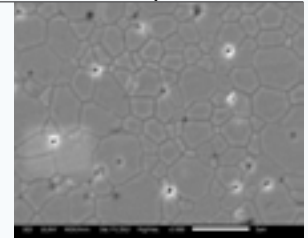
## Application

- Tibial osteotomy wedges
- Intervertebral cages
- Cranial implants
- Bone substitute
- Spine implants
- Orthopedic implants



| Microstructure             |                   | Values |
|----------------------------|-------------------|--------|
| Densification rate         | %                 | 96     |
| Density                    | g/cm <sup>3</sup> | 1.5    |
| Grain size after sintering | μm                | 2      |

SEM picture



## Mechanical properties at RT

|                       |     |     |
|-----------------------|-----|-----|
| 4-pt bending strength | MPa | 110 |
|-----------------------|-----|-----|

## General properties

|            |  |           |
|------------|--|-----------|
| Ca/P ratio |  | 1.66-1.71 |
|------------|--|-----------|

|                                                 |   |   |
|-------------------------------------------------|---|---|
| Foreign phases (CaO, TCP alpha, TCP beta, TTCP) | % | 5 |
|-------------------------------------------------|---|---|

|               |   |    |
|---------------|---|----|
| Cristallinity | % | 95 |
|---------------|---|----|

|              |     |    |
|--------------|-----|----|
| Heavy metals | ppm | 30 |
|--------------|-----|----|

# Tricalcium phosphate

## Properties

- Biocompatible
- Bioresorbable

## Application

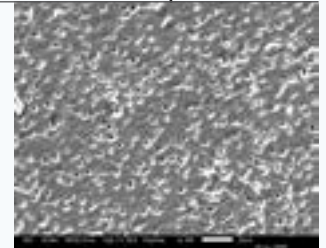
- Bone substitute



Available on C101 EASY, C900 FLEX

| Microstructure             |                   | Values |
|----------------------------|-------------------|--------|
| Densification rate         | %                 | 81     |
| Density                    | g/cm <sup>3</sup> | 2.47   |
| Grain size after sintering | μm                | 2.8    |

SEM picture



## General properties

- Presence of hydroxyapatite measured by X ray diffraction between 0% and 5%.
- No calcium pyrophosphate seen by infrared analysis.
- Ca/P ratio = 1.5

*Density can be adjusted according to customer's needs*

# Alumina toughened zirconia

## Properties

The ceramic ATZ combines both Alumina (20%) and Zirconia (80%) ceramics in one. The mix of these two combined offers several properties:

- Great hardness and tenacity
- Biocompatibility
- Resistance to wear and thermal shock

## Application

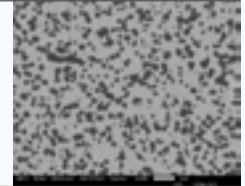
- Biomedical applications
- Industry



Available on C900 FLEX

| Microstructure             |                   | Values |
|----------------------------|-------------------|--------|
| Densification rate         | %                 | 99     |
| Density                    | g/cm <sup>3</sup> | 5.2    |
| Grain size after sintering | μm                | 0.5    |

SEM picture



## Mechanical properties

|                           |     |      |
|---------------------------|-----|------|
| 4-pt bending strength     | MPa | 1100 |
| Weibull modulus           |     | 5.8  |
| Theoretical young modulus | GPa | 220  |

## Thermal properties

|                            |          |      |
|----------------------------|----------|------|
| Thermal conductivity at RT | W/m.K    | 5.4  |
| Thermal expansion coef.    | at -50°C | 7.50 |
|                            | at 20°C  | 7.94 |
|                            | at 60°C  | 8.33 |

# Cordierite

## Properties

The cordierite is a magnesium alumina silicate material and has different properties:

- Low CTE
- Low thermal conductivity
- Wear resistant
- Good for vacuum application

## Application

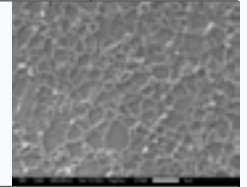
- Optical components for aerospace



Available on C900 FLEX

| Microstructure             |                   | Values |
|----------------------------|-------------------|--------|
| Densification rate         | %                 | 98     |
| Density                    | g/cm <sup>3</sup> | 2.5    |
| Grain size after sintering | μm                | 0.9    |

SEM picture



| Mechanical properties      |          |       |
|----------------------------|----------|-------|
| 4-pt bending strength      | MPa      | 150   |
| Weibull modulus            |          | 6.5   |
| Theoretical young modulus  | GPa      | 140   |
| Thermal properties         |          |       |
| Thermal conductivity at RT | W/m.K    | 3.8   |
| Thermal expansion coef.    | at -50°C | -0.87 |
|                            | at 20°C  | -0.10 |
|                            | at 60°C  | 0.22  |

# Silicore DS/SX

Investment casting

## Properties

- High mechanical resistance
- Porous ceramic, good leachability
- Very stable at high temperature
- Compatible with complex shapes like cores
- Used with all alloys except cobalt

## Application

Ceramic cores for lost wax foundry process.

These ceramic cores present a good behaviour during the casting of super alloys.

The material is suitable for DS and SX castings with continuous and low thermal expansions at high temperature.



| Microstructure                     |             | Values   |
|------------------------------------|-------------|----------|
| Silica/Zircon                      |             | 80/20    |
| Porosity                           | %           | 30       |
| <b>Mechanical properties at RT</b> |             |          |
| MOR 20°C                           | MPa         | 10       |
| Impregnated MOR                    | MPa         | 22       |
| <b>General properties</b>          |             |          |
| Cristobalite content               | %           |          |
| As fired:                          |             | 10       |
| After 1530°C:                      |             | 60       |
| Roughness (Ra)                     | μm          | 3        |
| Thermal expansion                  | 20 - 1000°C | 0.2%     |
|                                    | 20 - 1525°C | 0.4%     |
| Leachability                       |             | ± 80 min |

# Aluminium Nitride

## Properties

- High thermal conductivity
- Electrical insulation
- Good mechanical strength

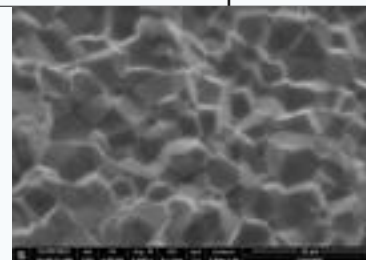
## Application

- Electronics substrate
- Heat exchanger
- Semiconductor
- Thermal chucks
- Scientific instrumentation
- Heat sink



Available on C101 EASY, C900 FLEX,  
C1000 FLEXMATIC

| Microstructure     |                   | Values |
|--------------------|-------------------|--------|
| Densification rate | %                 | 98     |
| Density            | g/cm <sup>3</sup> | 3.22   |



SEM picture

| Mechanical properties         |       |     |
|-------------------------------|-------|-----|
| 4-pt bending strength         | MPa   | 270 |
| Theoretical Young modulus     | GPa   | 368 |
| Thermal properties            |       |     |
| Thermal conductivity at RT    | W/m.K | 180 |
| Thermal conductivity at 300°C | W/m.K | 90  |

|                         |          |                                   |      |
|-------------------------|----------|-----------------------------------|------|
| Thermal expansion coef. | at -50°C | 10 <sup>-6</sup> .K <sup>-1</sup> | 1.84 |
|                         | at 20°C  |                                   | 2.89 |
|                         | at 60°C  |                                   | 3.38 |

Non contractual data for reference only - V17092025

# Silicon Nitride

Silicon nitride is one of the hardest and most resistant ceramics.

## Properties

- Good resistance to thermal shocks
- Good resistance to wear
- High mechanical properties
- Low density
- Good electrical insulation
- Resistance to corrosion (liquids and gas)

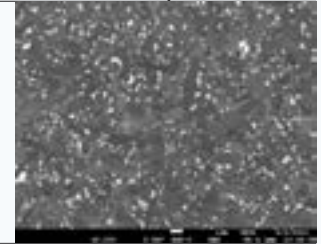


## Application

- Semi conductor
- Thermostructural parts: space, semiconductor, automobile
- Thermal exchanger
- Biomedical



| Microstructure     |                   | Values |
|--------------------|-------------------|--------|
| Densification rate | %                 | 98     |
| Density            | g/cm <sup>3</sup> | 3.13   |



SEM picture

| Mechanical properties      |          |      |
|----------------------------|----------|------|
| 4-pt bending strength      | MPa      | 750  |
| Weibull modulus            |          | 11   |
| Theoretical Young modulus  | GPa      | 290  |
| Thermal properties         |          |      |
| Thermal conductivity at RT | W/m.K    | 23.6 |
| Thermal expansion coef.    | at -50°C | 0.67 |
|                            | at 20°C  | 1.23 |
|                            | at 60°C  | 1.52 |



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