New Harmony >> New Solutions™

PROCESS PROVIDER FOR CERAMICS ADDITIVE MANUFACTURING

WHO WE ARE

GLOBAL PROCESS PROVIDER OF TECHNICAL CERAMICS AM

- 22 years of experience in Ceramics AM
- Pure player focusing on customer solutions
- Started by producing parts: user experience at its roots
- Top level expertise and continuous innovation
- Ability to identify and select new technologies or processes that can bring value to customer applications

- Founded in 2001 in France
- First equipment sale in 2015
- Sinto becomes the main shareholder in 2017
- HQ in France + 3DC Inc, GmbH, China + Japan
- 60 people globally

A POWERFUL SUPPORTIVE SHAREHOLDER

- Leading global industrial supplier, established in **1934**
- The world's largest manufacturer of foundry equipment
- Sinto Group has developed its know-how with solutions for foundries and surface treatment, evolving to the SFS
- **SMART FACTORY SOLUTIONS**: monitoring & QA, industrial health and safety, material handling, mechatronics and automation, consumables
- Sinto now expands its expertise to new fields ("**New Business Division**") including additive manufacturing

Key figures:

- 5000 people
- +1.5 billion $ turnover
- Continuously profitable (>5% EBITDA)
- Local presence in 16 countries

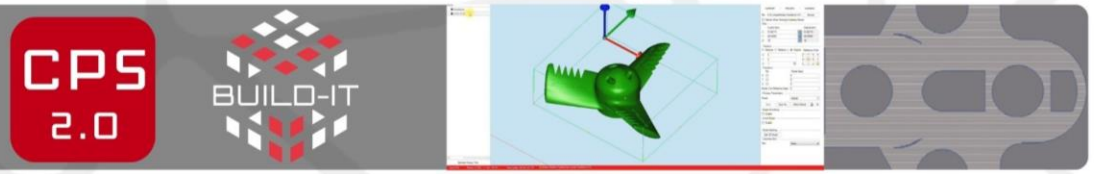
3D CERAM – PROCESS PROVIDER

EQUIPEMENT

- MACHINES
- CERAKLEANER
- FURNACES

SOFTWARE

- Ceramaker Printing Software
- BUILD-IT
- Video Data Analysis (V.DA.)



MIX FOR CERAMAKERS

- CERAMICS SLURRY (OXIDE / NO OXIDE)
- DEVELOPMENT

DEDICATED SERVICES

- MAINTENANCE
- TECHNICAL SUPPORT
- TRAINING

www.3dceram.com

PRODUCT PORTFOLIO ALLOWING FOR SCALE UP

- Core product portfolio based on the **SLA process**: mature technology with proven value-added, reliability and throughput/productivity capacity
- Producing accurate fully dense technical ceramics with top surface finish

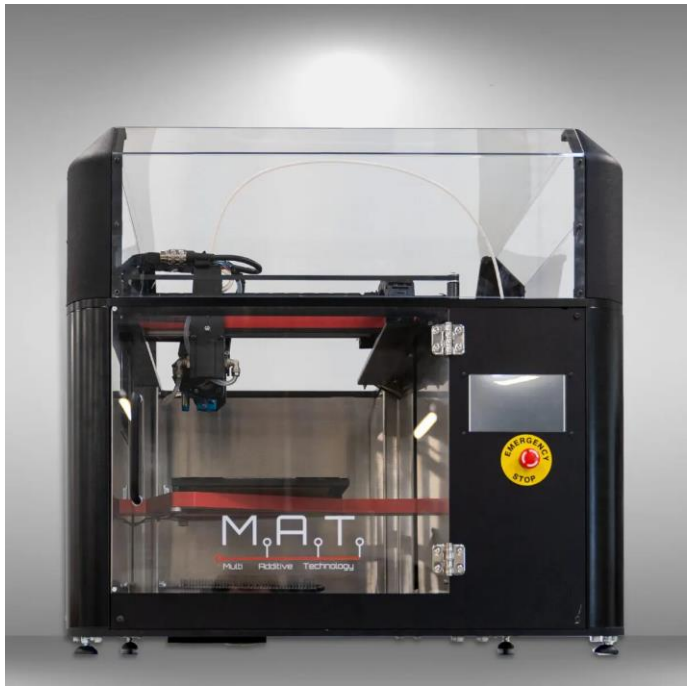
4 parts in 1h20 – 20 mn/part

48 parts in 6h10 – 7,7 mn/part

112 parts in 12h – 6,4 mn/part

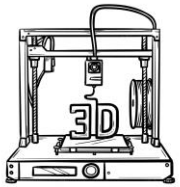
PRODUCT PORTFOLIO INCLUDING COMPLEMENTARY PROCESSES

- To match different applications needs, we have developped internally the M.A.T.: **Multi Additive Technology**
  - A desktop printer allowing to produce dense parts from filaments, pellets or slurries
  - A milling head ensures a smooth surface finish
  - Main benefits: good parts quality, low cost per part, wide range of materials, flexibility



To go further and meet customers requirements, we have access to other processes:

- **Binder jetting:** fast, for small to big porous parts
- **Screen printing:** ultrafast, for small dense parts
- **Slurry Deposition:** for very large dense parts



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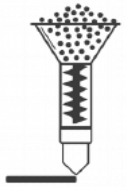
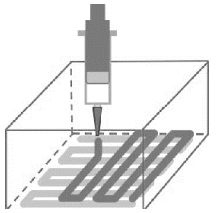
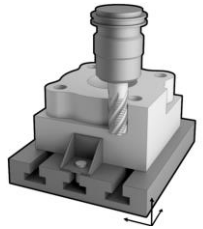


Pellet Extrusion



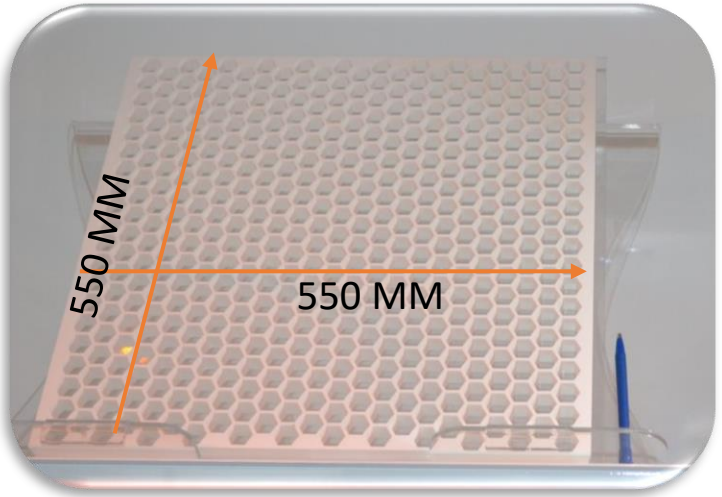
Robocasting



Milling

UNIQUE ON THE DENSE CERAMICS MARKET: Scale up and Big parts

Approx 500mm diameter

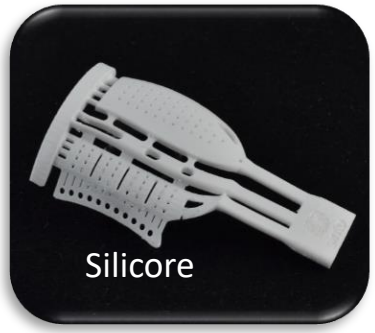


4 to 48 to 112 parts per job ; 20 to 8 to 6,4 minutes / part

Build platform of 600*600*300 mm

STANDARD SLA CERAMIC MATERIALS

OXIDES



NON OXIDES

Developped and produced in-house by 3DCeram

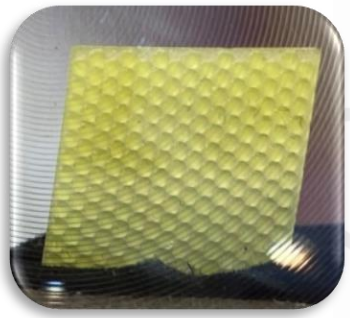
+

Possibility to develop custom materials
for customers

OUR CUSTOMERS CAN DEVELOP THEIR FORMULATIONS

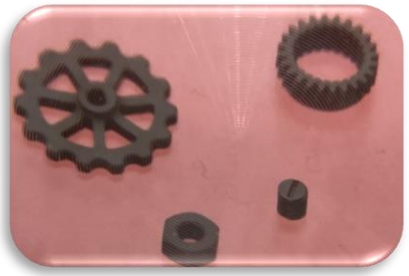
CREATZ3D CERAMICS
Redefining Innovation

SPINEL



YAG

Skoltech
Skolkovo Institute of Science and Technology



REGOLITH

Mateis

CERIA BASED

ZIRCONIA

2024 - 3D Ceram New Expansion Phase

3 key pillars

- Master deeply the full production process
- Focus on key applications development and validation
- Industrialize the full process based on customer needs

Do it especially via strategic partnerships and collaborations in our ecosystem

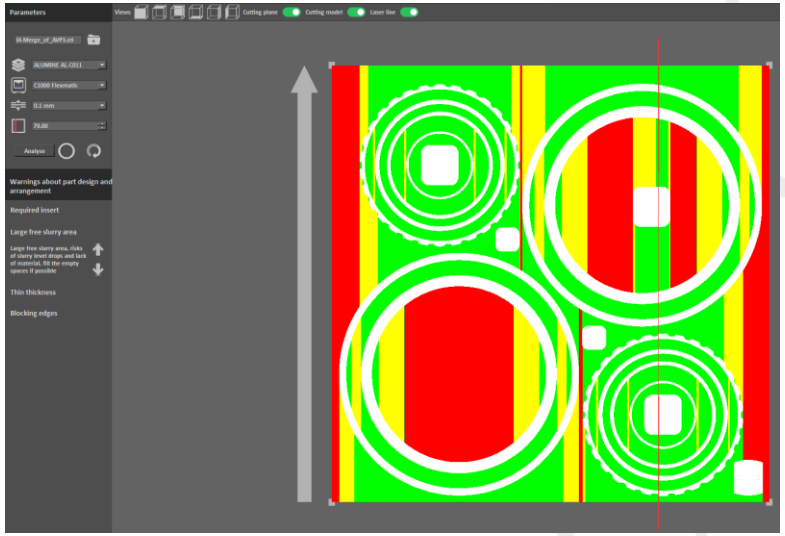
Already engaged (as examples)

- Process mastery and optimization via AI and machine learning
- Customized material and process development for orthodontics
- Customized machine and workflow for green hydrogen production

New energy, New mobility, New space, New defense, New health, and semicons have huge needs.

AM technical ceramics with the right partner and approach have solutions.

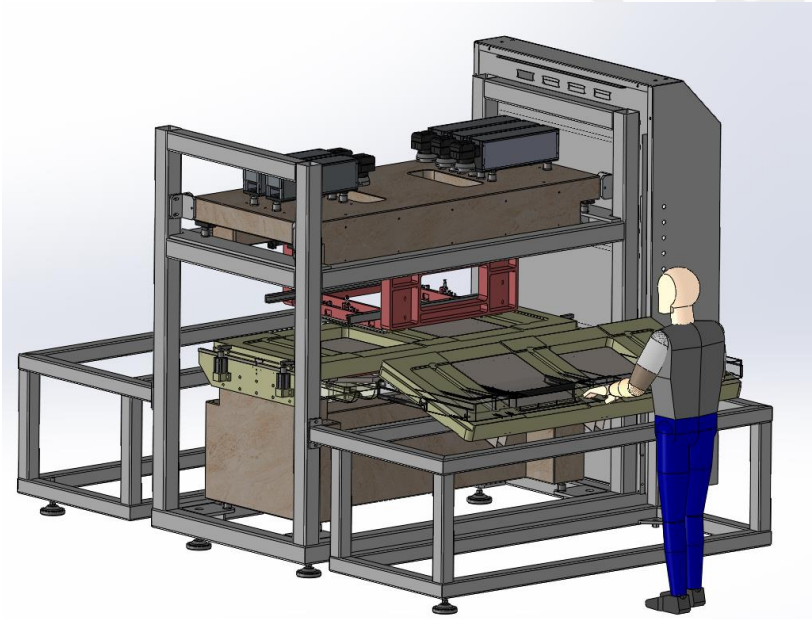
EXAMPLE OF INDUSTRIALIZATION DEVELOPMENTS



CERIA SUITE

Bringing together all the expertise and experience of 3D Ceram in a tool (predictive and corrective) for user's benefits. Use the capabilities of artificial intelligence and machine learning for this purpose.

- ✓ Accelerated learning for operators. Education for designers.
- ✓ Faster parts prep, reduced errors, reduced risk of bad parts.
- ✓ Reduce the competency level needed to print.
- ✓ Optimization: allows to make more complex pieces and/or make more pieces on a print job.



C2000 DUAL solution

Optimize the equipment design and the process to achieve productivity & cost-effectiveness.

- ✓ Reduced time with 2 platforms and 2 scrapers
- ✓ Reduced time with 8 lasers
- ✓ Reduced cleaning time with titled vats
- ✓ Less manpower, better recycling, more parts

APPLICATION EXAMPLES

3DCERAM

LUXURY

Zirconia is the favored material in the luxury industry.

From the SLA process, once polished, the surface appearance of this ceramic is very glossy.

Watches:

- 3D-printed ceramic watch cases offer both lightness and durability. Ceramic is valued for its scratch resistance and elegant aesthetic, making it a popular choice for luxury watches.

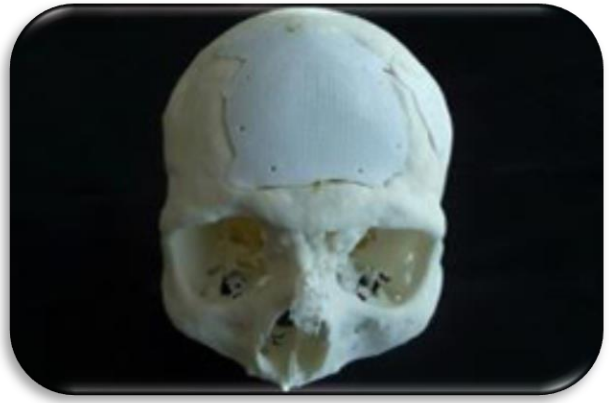
Jewelry:

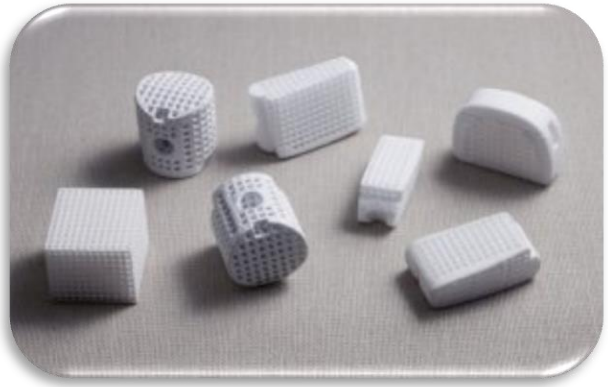
- rings, necklaces, earrings can be 3D printed in ceramic. The precision and characteristics of SLA 3D printing allows for the creation of unique designs.

Luxury acessories:

- cutleries, perfume caps, fashion accessories, … Designers can free up their creativity.

APPLICATIONS VALIDATED IN BIOMEDICAL AND DENTAL

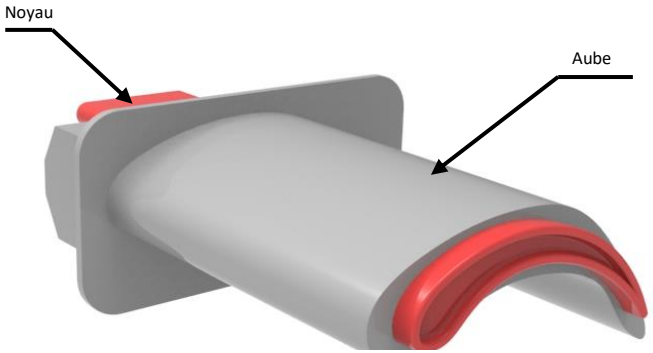




ZIRCONIA 3Y	• Excellent mechanical properties • Chemical inertness • High hardness
HYDROXYAPATITE (HAP)	• Biocompatibility • Excellent bioactivity • Good osseointegration
TRICALCIUM PHOSPHATE (TCP)	• Biocompatible • Bioresorbable
TRANSLUCENT ALUMINA	• Excellent mechanical properties • Chemical inertness • Aesthetically pleasing
ALUMINA	• Biocompatibility • Excellent bioactivity

INVESTMENT CASTING (Foundry cores)

- **Shape of cores** are becoming more complex to create more efficient cooling channels and then lower fuel consumption
- **No tooling**: faster development time and lower development cost for prototype
- **Small series** production is feasible
- **High quality of cores**: high resolution, roughness, good leachability



APPLICATIONS IN OIL & GAS

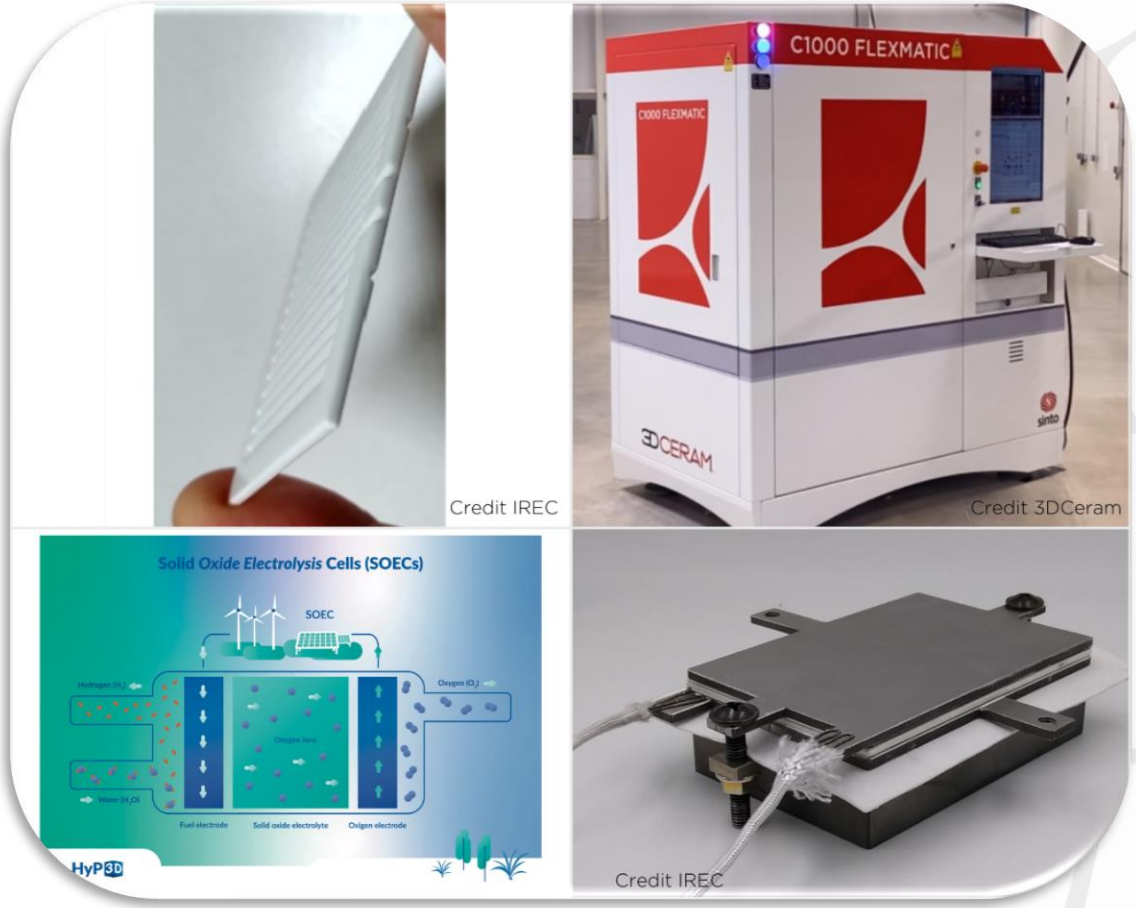
- ✓ Heat exchangers
- ✓ Parts for slurry services in refineries
- ✓ Labyrinth cages (complex shapes with internal channels)
- ✓ Tungsten carbide parts (i.e. choke wellhead) converted in ceramics
- ✓ Ball valves and seat components
- ✓ Spray nozzles in thermal power plants (i.e. HP bypass)

ALUMINA	• Excellent mechanical properties • Chemical inertness • High hardness
ALUMINIUM NITRIDE	• High thermal conductivity • Electrical insulation
ZIRCONIA	• Excellent mechanical properties • Heat insulating • Oxygen-ion conductivity
SILICON NITRIDE	• Resistance to thermal shocks • Low density • Resistance to corrosion • Wear resistance
SiC (with M.A.T)	• Ultra high hardness • Chemical inertness at high temp • High thermal conductivity & low exp

RENEWABLE ENERGY APPLICATIONS

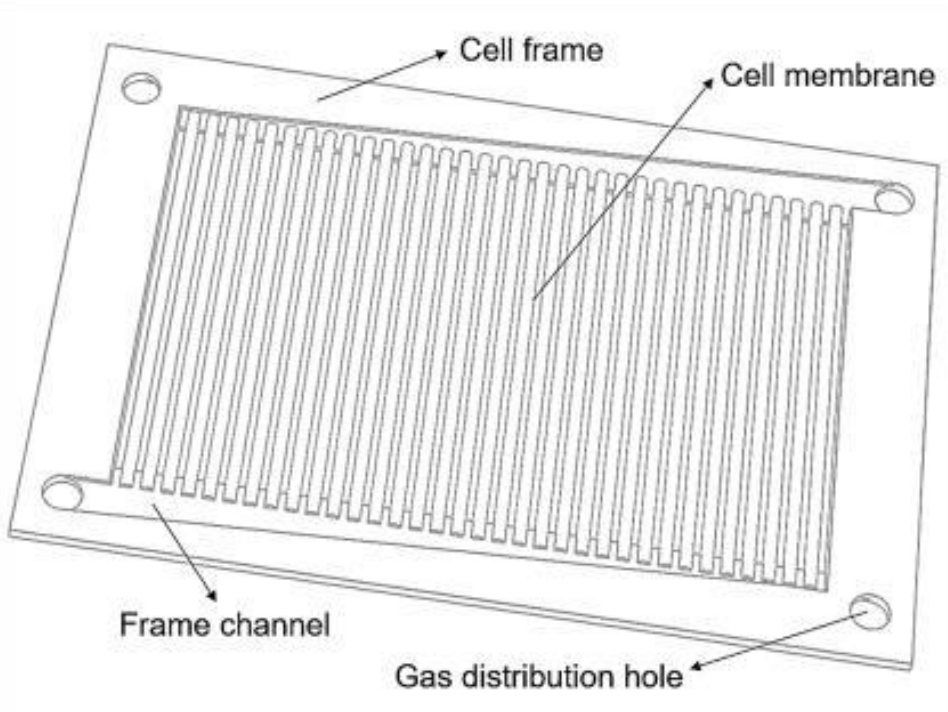
- Ceramics play important role in different **Energy innovative projects** :
  - Solid Fuel and Electrolyze Cells
  - Green Hydrogen production
- Why 3D printing:
  - To reduce the number of process steps
  - To increase design flexibility
  - To improve durability
  - To increase the reactivity surface
  - To improve mechanical properties
  - To integrate additional functions to cells

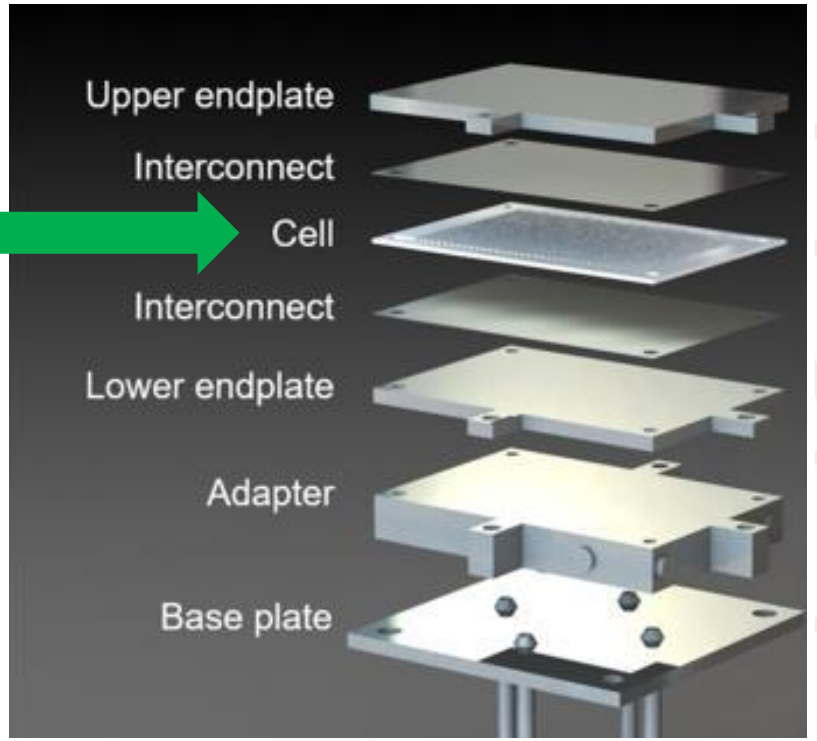
- For example, the Hyp3D project brings together stakeholders to achieve the production of hydrogen through electrolysis.
- This is expected to allow for a CO2 emission reduction of 80 million tons.



HYP3D: high-pressure electrolysis

3D printing of complex ceramic electrolytes





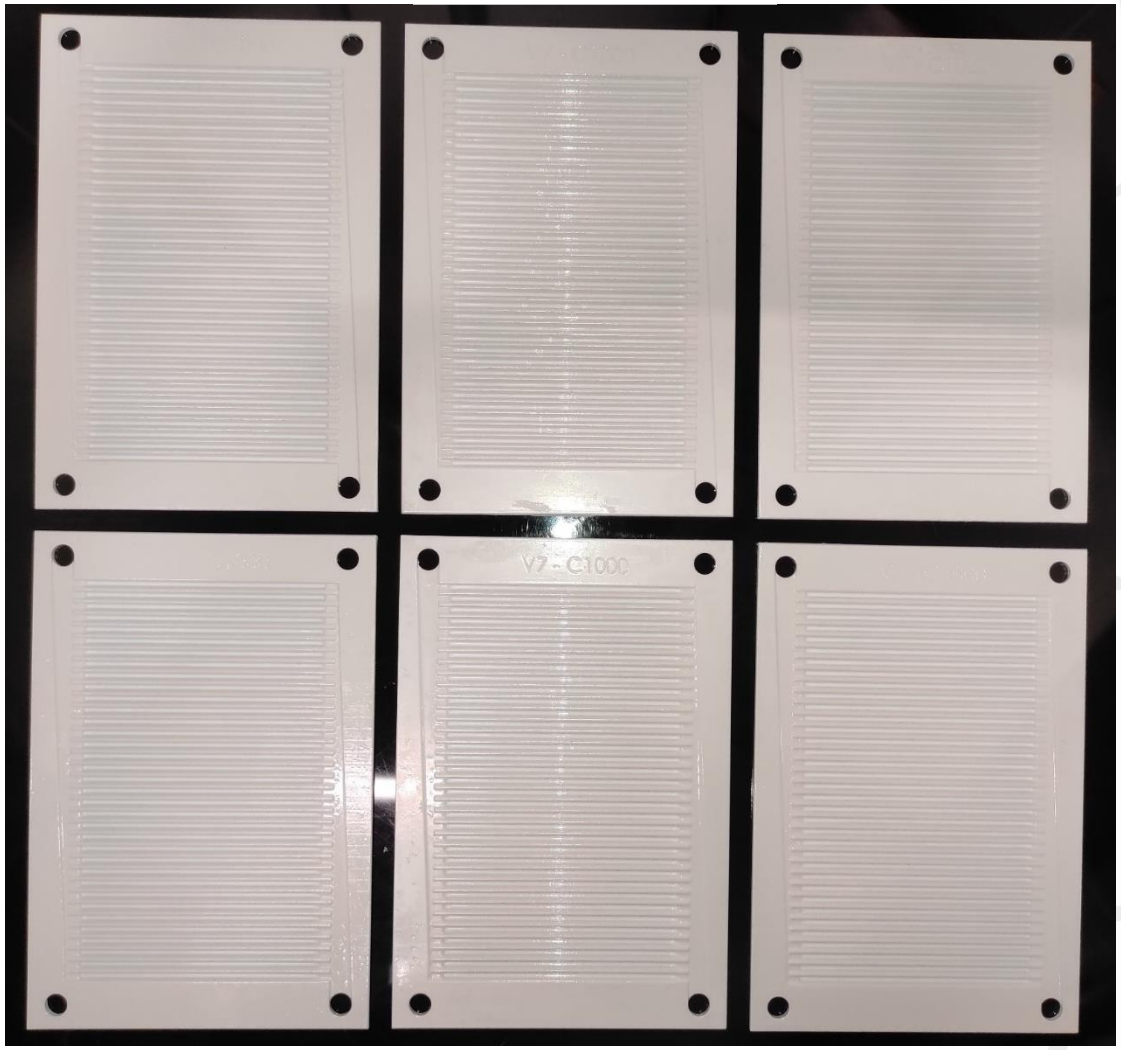
- ✓ Mechanical properties optimisation
- ✓ Increase in reactive surface
- ✓ Functionalization of the cell

→

- Resistance to differential pressure
- Efficiency
- Compact design

DISRUPTIVE SOECs

140x90x2mm



6 SOEC cells printed simultaneously in 8 hours on a C1000 FLEXMATIC printer

SEMICONDUCTORS

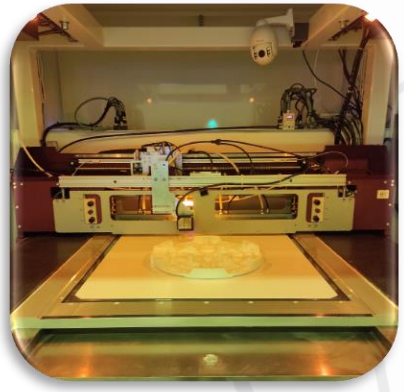
Parts in ceramics

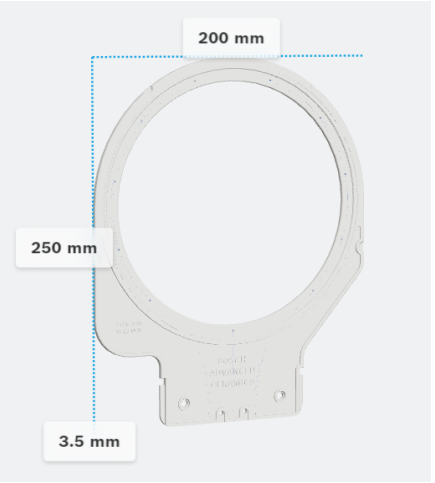
- Wafer transport trays, chucking/suction tables and robot arms
- Gas introduction ports
- In the plasma etching process, ceramics are used for chambers, electrostatics chucks, nozzles, and rings

- **Part 1:** 380 mm diameter ceramic gas distribution ring designed for PEALD process (Alumina System GmbH).
  Innovative geometry of the ring, capable of supplying two gases simultaneously, represents a breakthrough for Plasma Enhanced Atomic Layer Deposition (PEALD) process. Printed on a CERAMAKER C3600 printer, the ring was produced in separate pieces in a single run and joined with glass solder.

- **Part 2:** large ring blade (Bosch Advanced Ceramics).
  The large ring blade is an integral part of an automated actuator specifically designed for the handling and processing of 200 mm wafers. This particular application requires exceptional chemical resistance and electrical insulation properties. The part has an exceptionally high level of flatness (less than 100 µm) and internal channels that facilitate efficient gas distribution or vacuum processes.

- **Part 3:** Suction plate for a Sinto's customer in Japan.

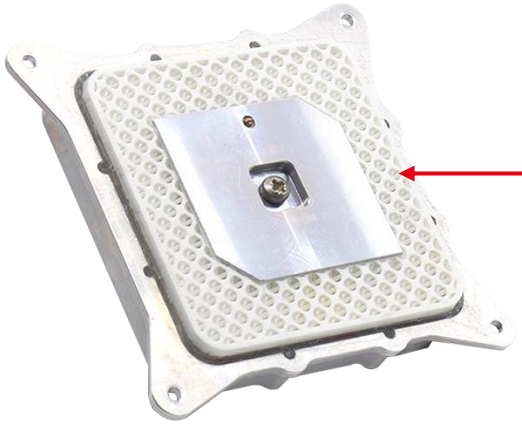




AEROSPACE

Antennas for nano-satellites

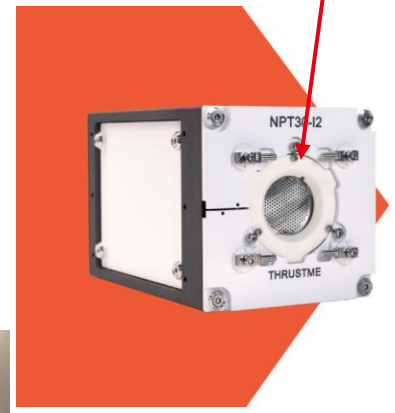
- Nanosats for LEO (low earth orbit at 400-600 km altitude) for telecommunications
- Why technical ceramics: due to zirconia permittivity
- Why AM:
  - For lattice design
  - SLA selected for low roughness, thin details, accuracy and repeatability

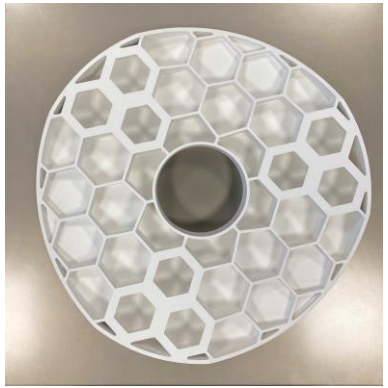


3D Ceram parts

Thrusters for nano-satellites

- Innovative in-orbit propulsion systems for nanosats constellations
- Why technical ceramics: due to zirconia heat insulation and ion conductivity
- Why AM:
  - For complex and precise shape
  - SLA selected for low roughness, thin details, accuracy and repeatability

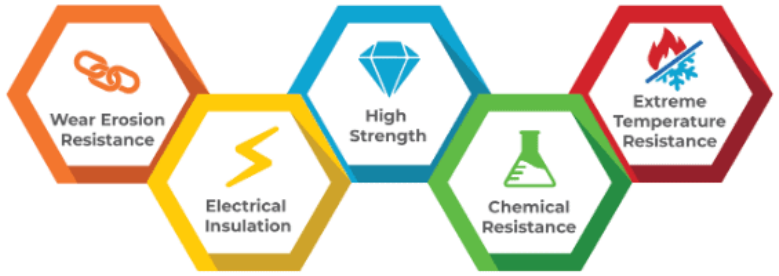




And mirror base for conventional space

DEFENSE - NUCLEAR

CONFIDENTIAL APPLICATIONS



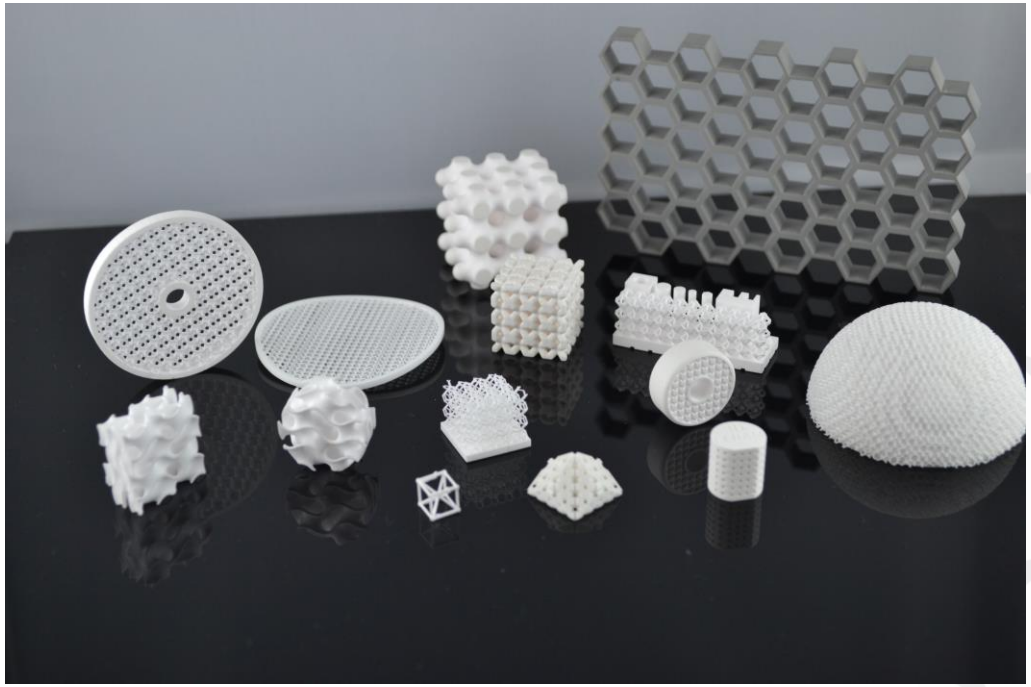
3D PRINTING CERAMICS APPLICATIONS

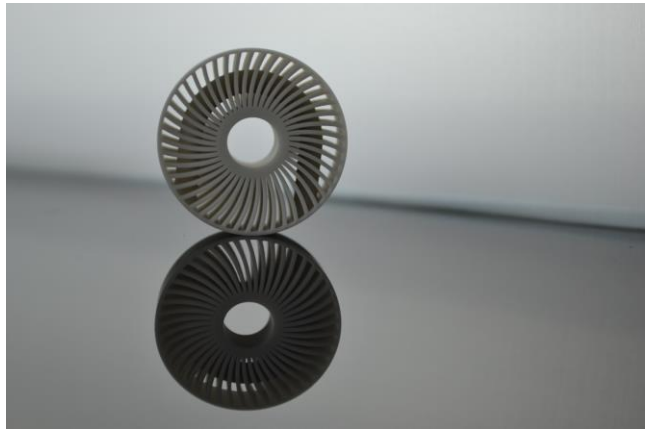
DEFENSE

ALUMINA	• Excellent mechanical properties • Chemical inertness • High hardness
ALUMINIUM NITRIDE	• High thermal conductivity • Electrical insulation
SILICORE	• Porous ceramic, good leachability • High temperature compatibility • Complex shapes like cores
SILICON NITRIDE	• Resistance to thermal shocks • Low density • Resistance to corrosion • Wear resistance
ZIRCONIA	• Excellent mechanical properties • Heat insulating • Oxygen-ion conductivity

OTHER USUAL APPLICATIONS

- ✓ **Filtering of fluids and gases**: ceramics are chemically inert and resist to corrosion and temperature: filters, dies, tooling, gaskets, tightness rings;
- ✓ **High temperature applications**: injectors, nozzles, temperature probes, pressure and temperature sensors, heating components, heat recovery components;
- ✓ **Electronic insulation**: insulation components, connectors, inserts, tubes with cooling channels inside, different insulation disks and bushings;
- ✓ **Heat exchange**: heat exchangers with internal channels, furnace inserts for cooling;
- ✓ Various **wearing parts** because of resistance to abrasion of ceramics and longer life cycle of ceramic parts: different kinds of nozzles for fluids and gases etc.;
- ✓ Different **hardware** because of good mechanical resistance and stiffness: clamps, fixing supports, housings etc.





Thank you

3DCERAM