New Harmony >> New Solutions™

Innovative zirconia-based material shaped by SLA 3D printing

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ADDITIVE MANUFACTURING AROUND THE WORLD

Created in 2001
Print Ceramic since 2007
The pionner !

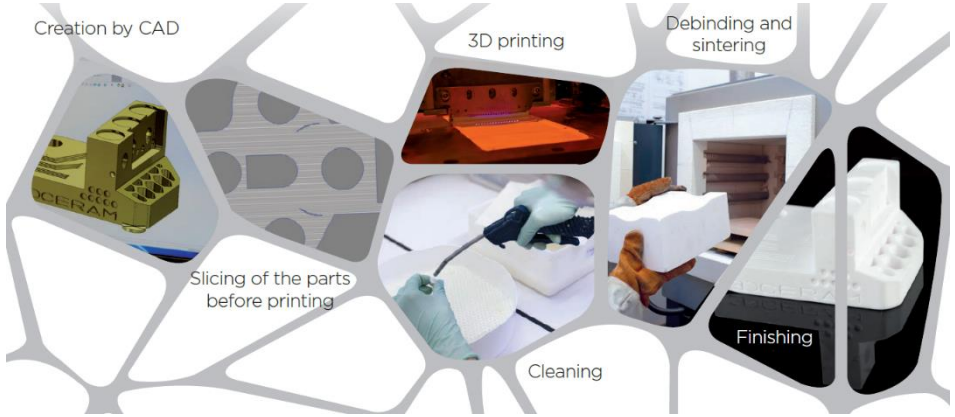
SINTO – Main shareholder –
4000 people. & 1 billion €

Headquarter in Grand Ledge (MI)
190 People
150 M$ in USA
New printing lab with several machines

New building (more than 3000 m²) since February 2021

3DCERAM

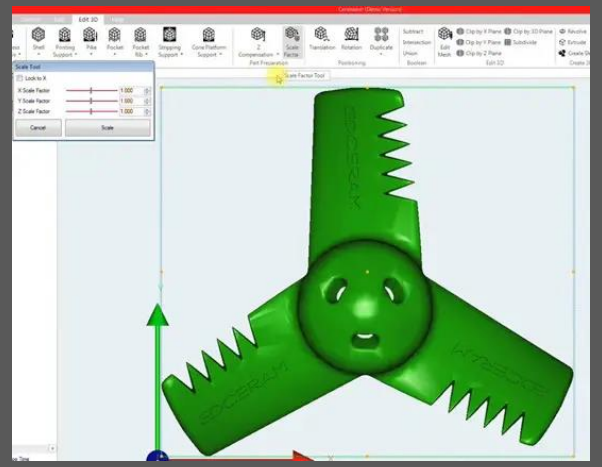
PROCESS PROVIDER



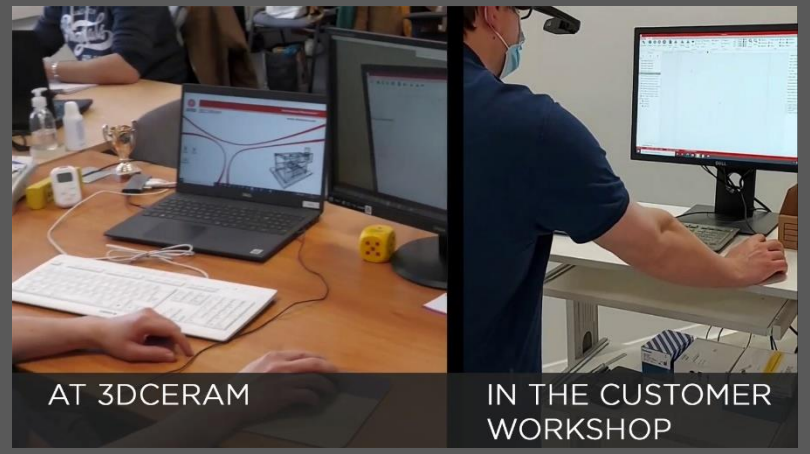
A COMPLETE RANGE OF PRINTER

MIX for CERAMAKERS

SOFTWARE

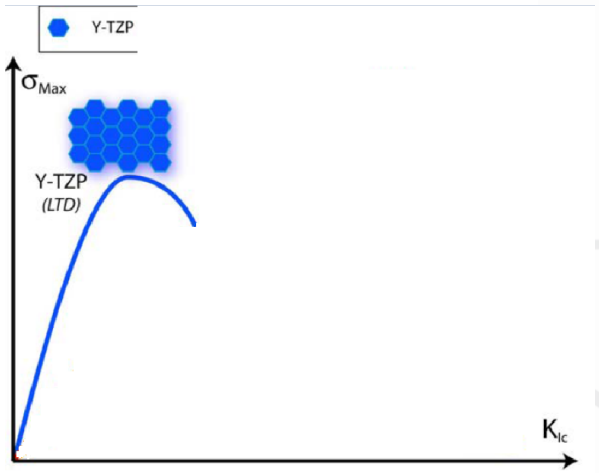


DEDICATED SERVICES

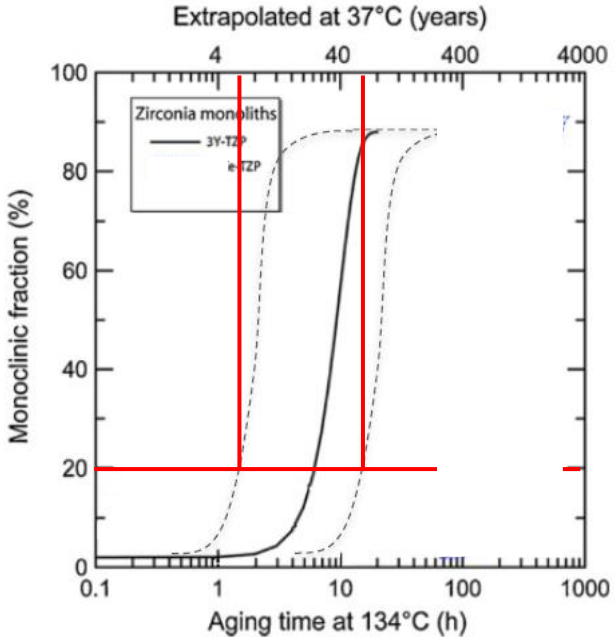


Aging of 3YTZP

- Zirconia with 3% of Yttria was the first zirconia used for orthopaedics implants thanks to some properties:
  - Biocompatibility
  - Wear resistance
  - Mechanical properties around 1000 Mpa
  - Toughness

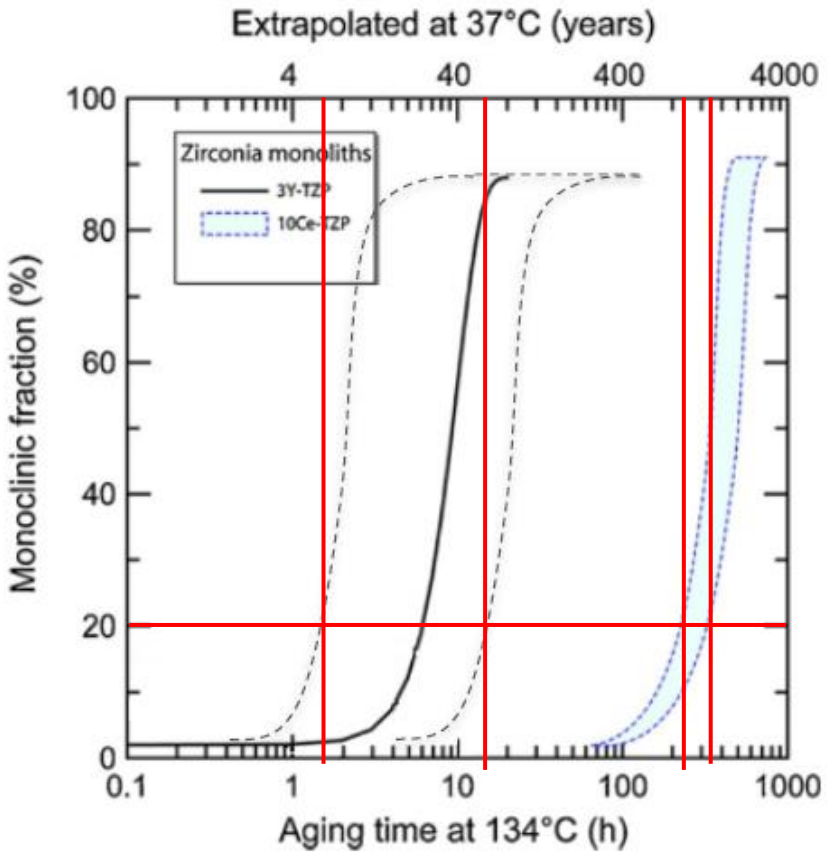


- 3YTZP usage in Hip implant was stopped in 2001 due to some breakages and damages on implants:
  - Due to aging (acceleration of aging due to water) and the monoclinic – quadratic transformation with water
  - It is due to the oxygen vacancies which increase aging



Aging of 3YTZP

- There are several approaches to solve this issue for 3YTZP and obtain the best compromise between mechanical properties and aging
  - ZTA (Zirconia Toughened Alumina) but still using Y TZP and then potential aging issue
  - Zirconia doped with Cerium: Ce-TZP



New Ceramic for orthopedic application

- Collaboration of three National lab
- Subject of the study with Jerome Chevalier
  - developed a new ceramic for orthopedic application exhibiting a true plastic deformation BEFORE failure
  - with equivalent properties with 3D SLA and CIP (Cold Isostatic Pressing)
- 3Dceram developed the presets and the mix:

ON-DEMAND

Powder: Customer
Binders: 3DCERAM
Preset: 3DCERAM

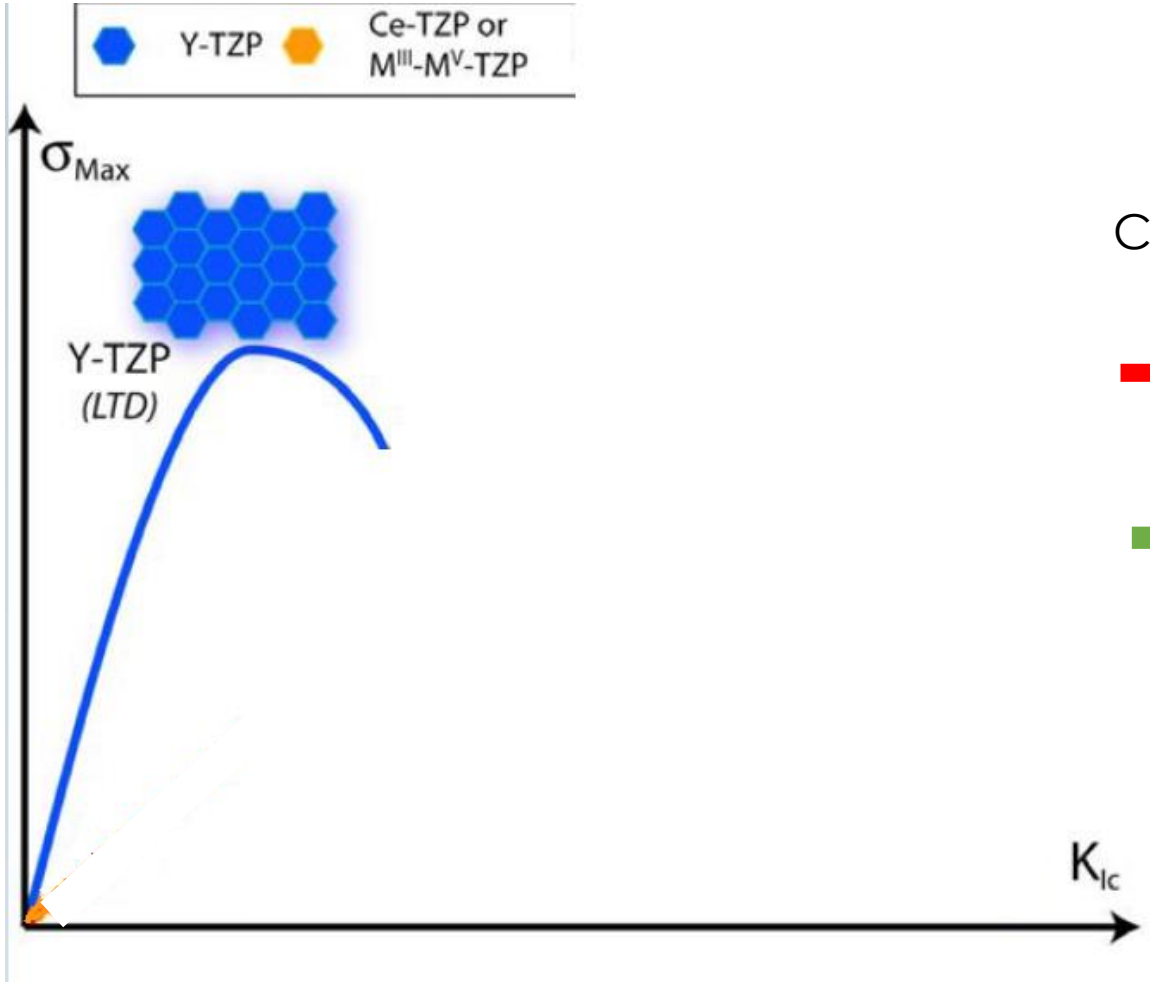
STANDARD

Powder: 3DCERAM
Binders: 3DCERAM
Preset: 3DCERAM

OPEN PARAMETERS

Powder: Customer
Binders: Customer
Preset: Customer

Properties of Ce-TZP

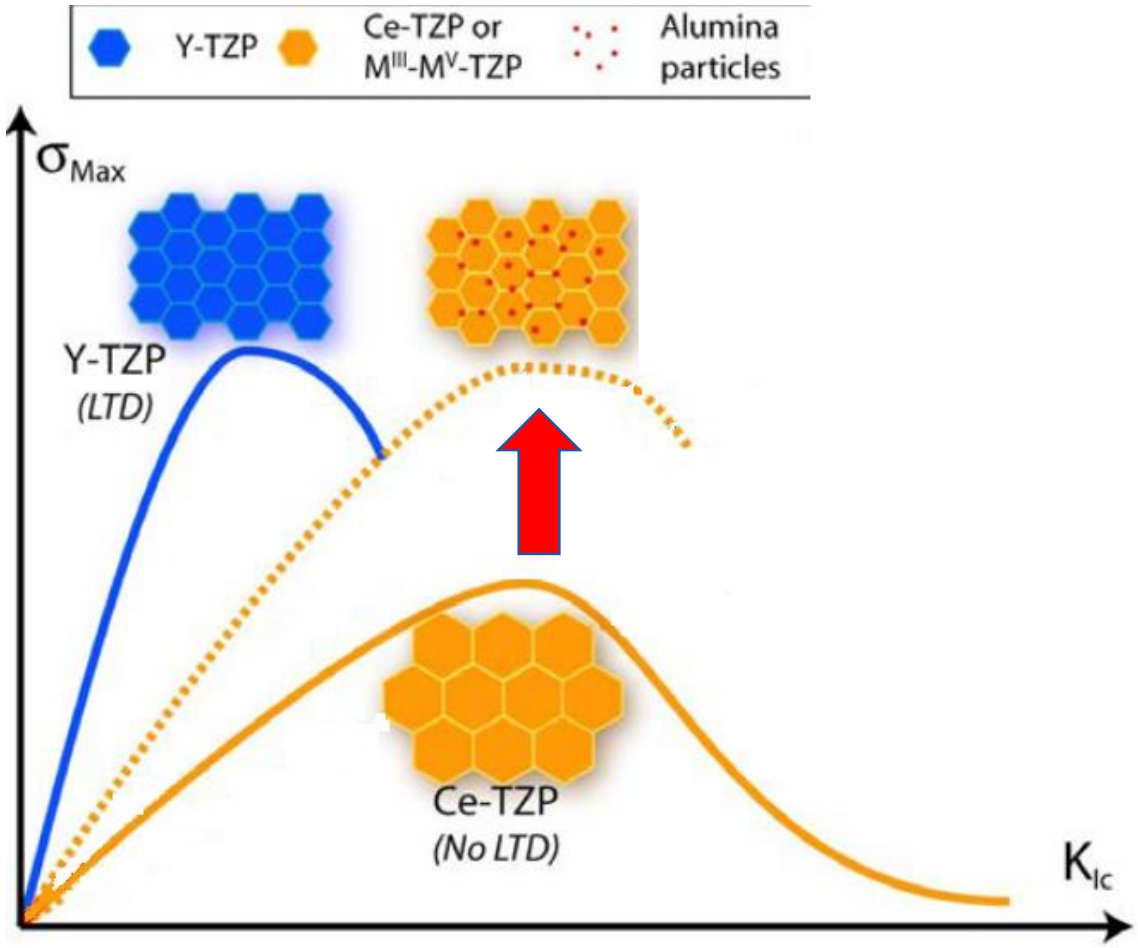


Ce-TZP (10%) versus 3YTZP

− Hardness (1000 vs 1200 Vickers)
Mechanical properties (400 vs 1000 MPa)

+ Aging
Toughness KIC (**7,8** vs 5,4 MPa√m)

Properties of Ce-TZP: composite

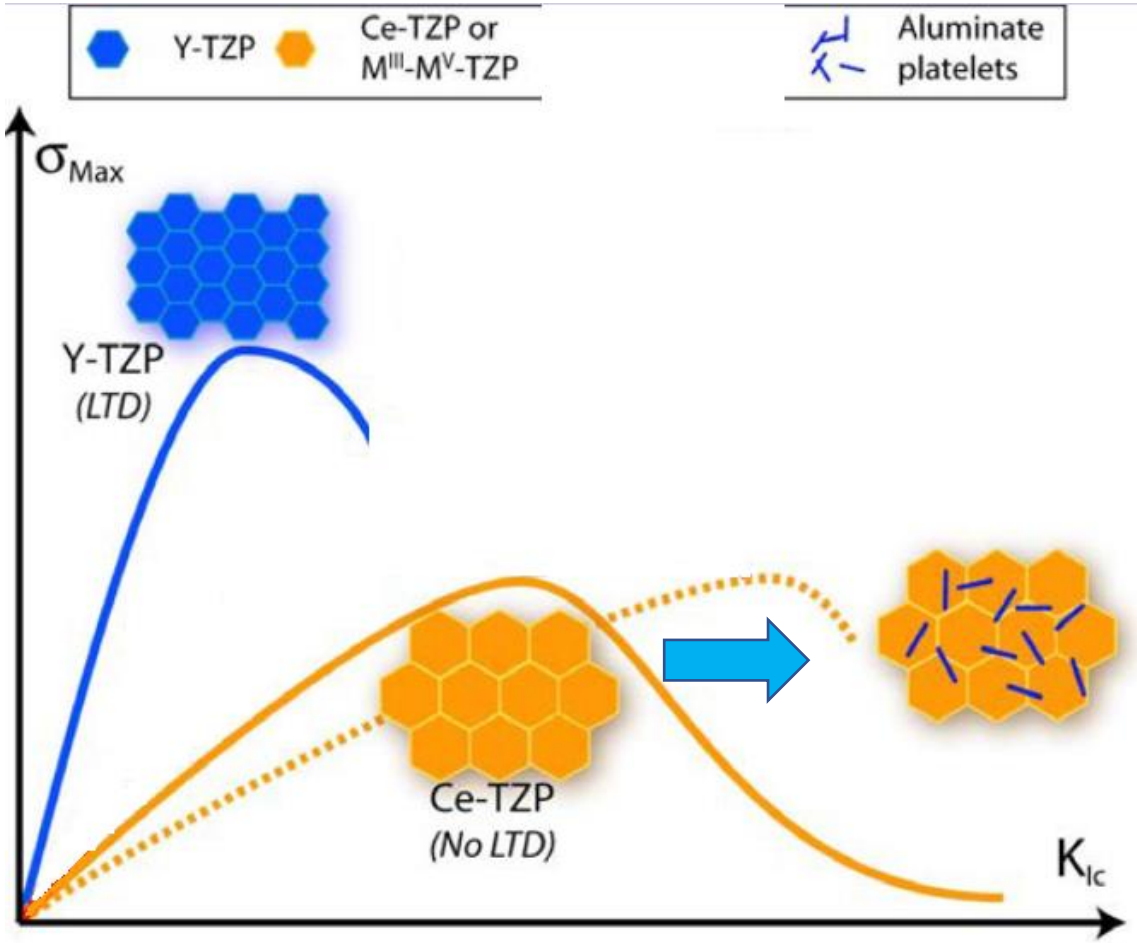


In order to **increase mechanical properties**, it was decided to add a second phasis

- Alumina nanoparticles (100 nm)

The aim of the alumina nanoparticles is too avoid grains growth for the Ce-TZP matrix during sintering

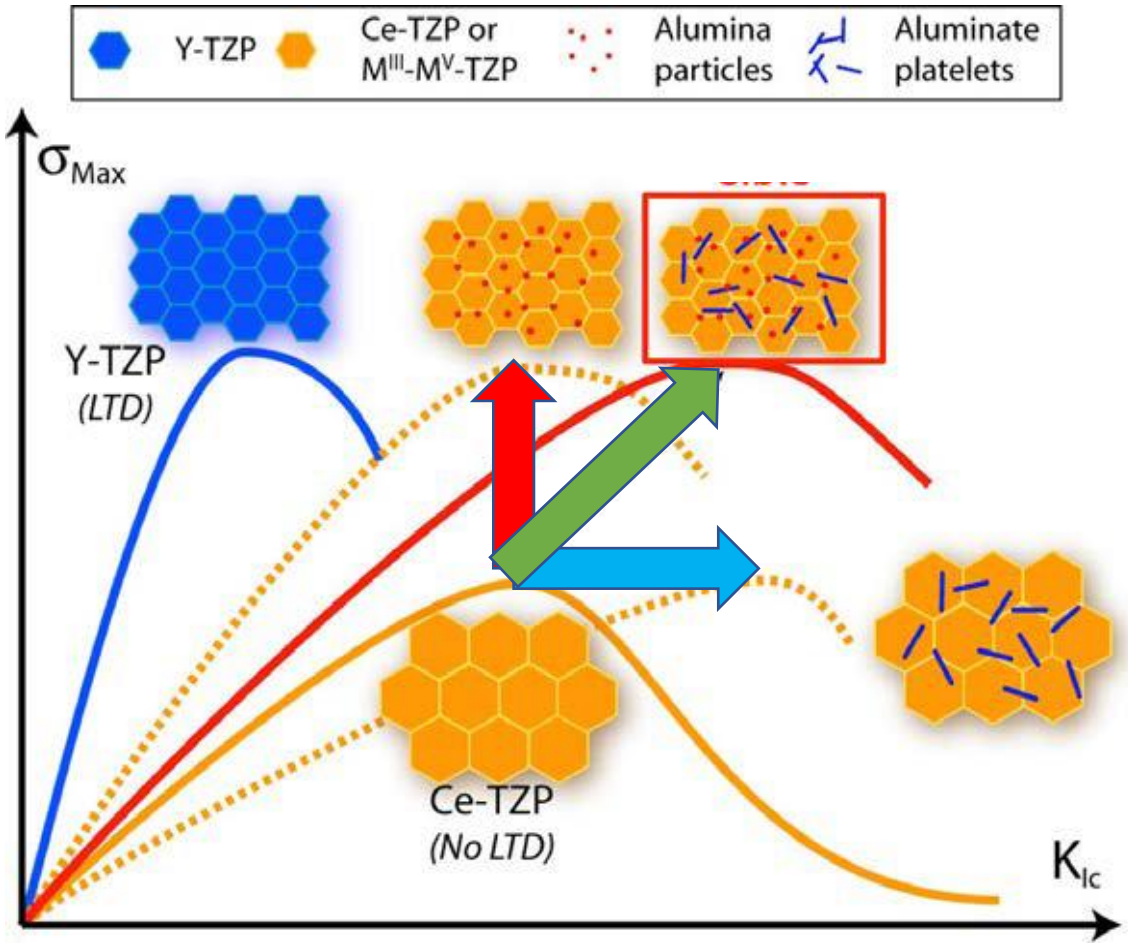
Properties of Ce-TZP: composite



In order to **increase the toughness**, it was decided to add a third phasis with platelets

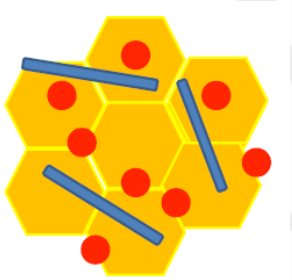
- Aluminate strontium platelets

Properties of Ce-TZP: composite



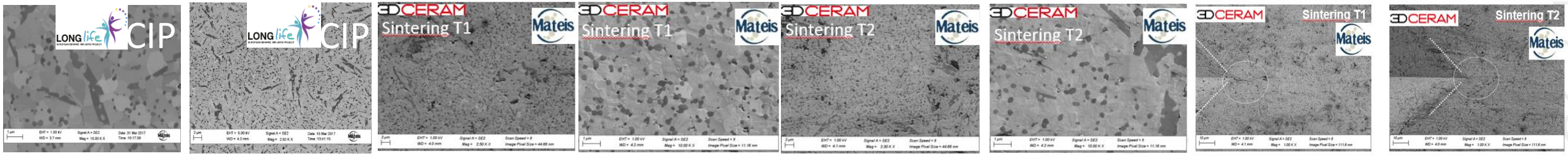
New material is a composite with Ce-TZP matrix, with alumina particles for mechanical properties and alumina platelets for toughness

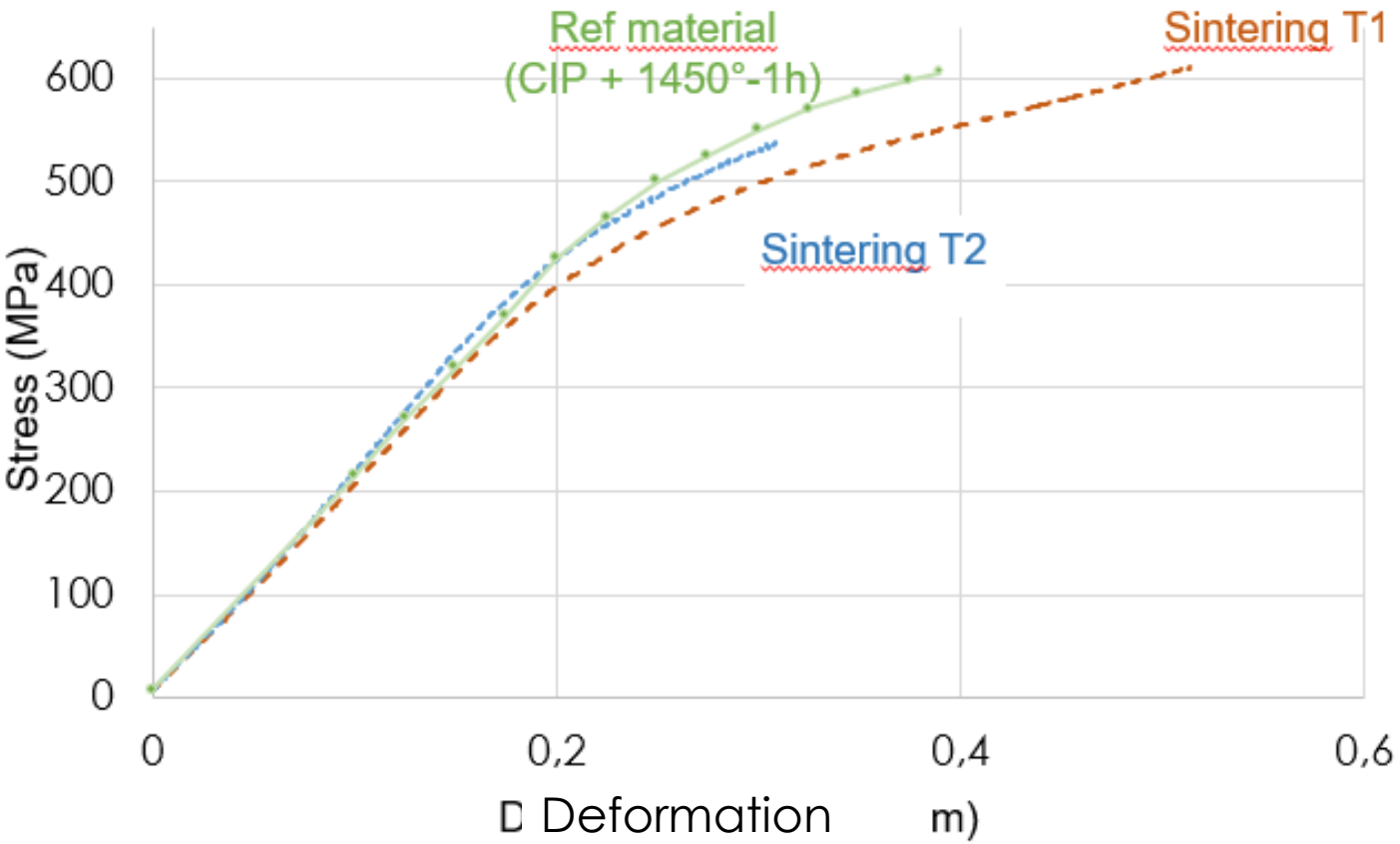
- Matrix: **Ce-TZP (84% vol)**
- Phase 1: **Al_2O_3 (8% vol)**
- Phase 2: **$SrAl_{12}O_{19}$ (8% vol)**



Printed on a C100 LAB by 3DCERAM

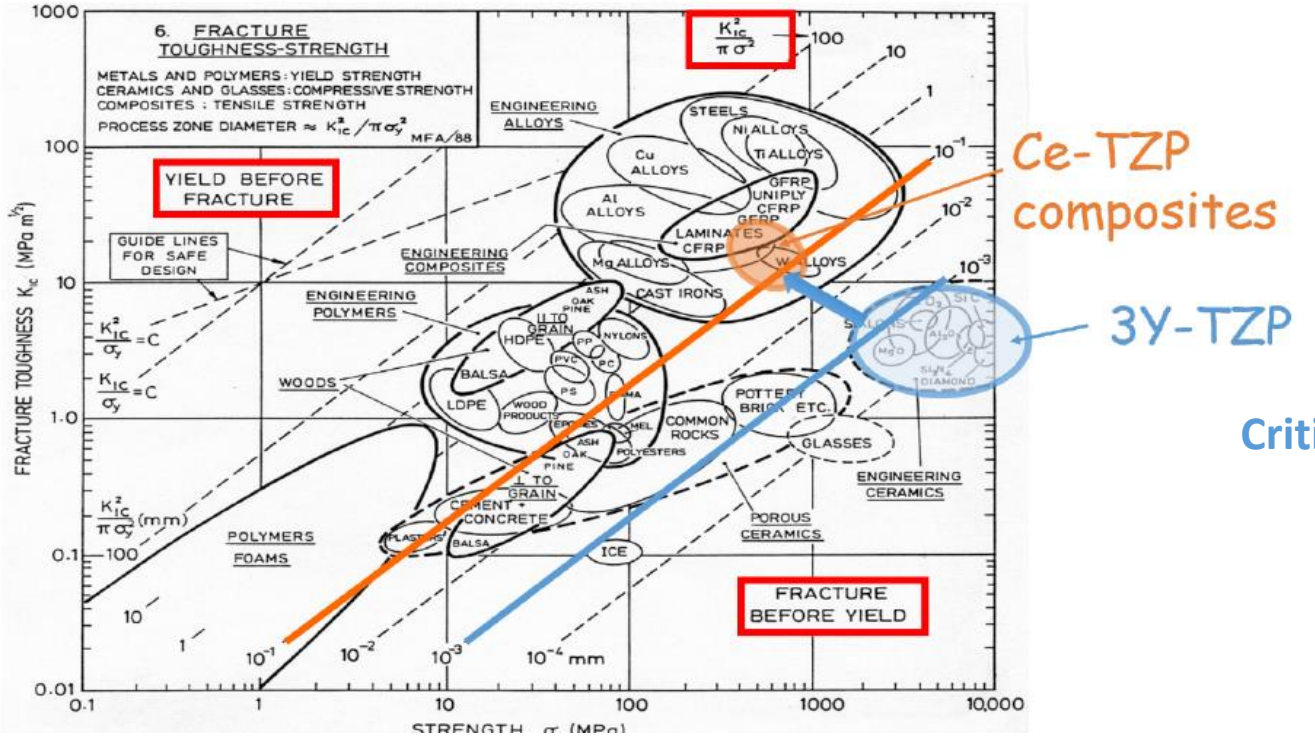
Mechanical properties





- 30 beams 40 x 4 x 3 mm
- T1 and T2 for sintering temperature
- Weibull modulus = **40**
- 3DCERAM SLA technology provides the same properties than the ones obtained with conventional processes (CIP)

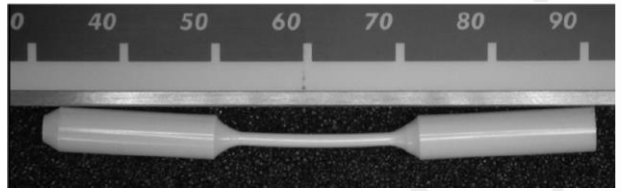
‘Defect tolerant’ ceramic for mass customisation



Ce-TZP composites

3Y-TZP

Critical defect 100 µm!



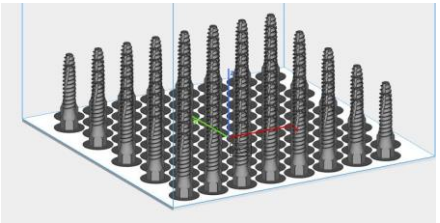
Critical defect 1 µm!

- With Weibull modulus of 40 and critical defects of 100 µm, we achieved more ‘defect-tolerant’ ceramics
- 3D printing and mass customisation needs material developed specially for AM

Conditions to have profitable and industrial solutions

- More efficient: large printing area means less down time to change the printing platform
- Fast printing <->high layer thickness only possible with SLA Laser (higher power)
- Automatic post process: only possible with 3DCS SLA

3D PRINTER	C101 LAB/FAB	C1000 FLEXMATIC	C3600 ULTIMATE
BUILD PLATFORM (mm)	100*100*150	320*320*200	600*600*300
LASER	1	1/2	4
Number of implant			
Printing time per implant (s)			
Raw material cost per implant ($)			

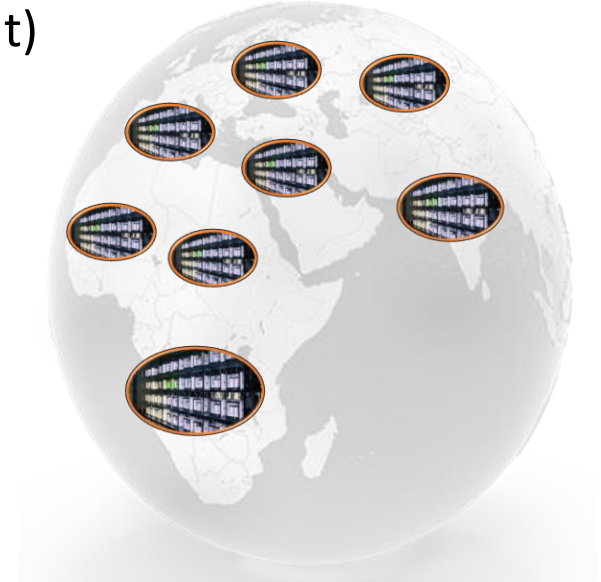


Conclusions

- Success story :
  - collaboration between 3DCS and National Labs developed a new ceramic material with plastic behavior shaped by SLA for biomedical applications
  - Material properties after sintering are the same as CIP

- Those development can only be interested for industrial people IF manufacturing price with 3D is low:
  - Large printing area, (small printing platform are nice but not efficient!)
  - Fast printing process (high laser output)
  - Automatic post process

- Next steps: Printing farms…



Thank you !
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