

3D laser printing of Hydroxyapatite by SLS/M

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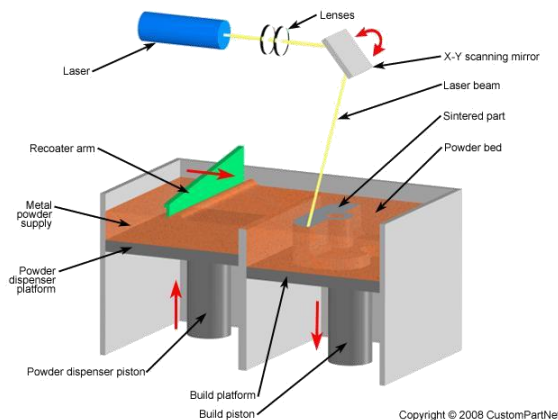
S: Secondment

- NEXT-3D Mid-term meeting, Brussels, Nov 24th 2016 -



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What phenomena are significant in SLS/M ?



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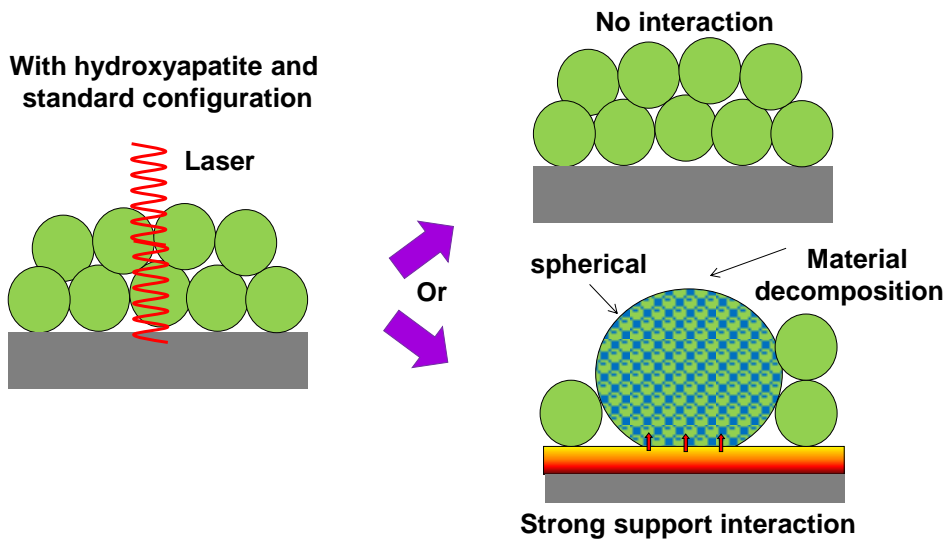
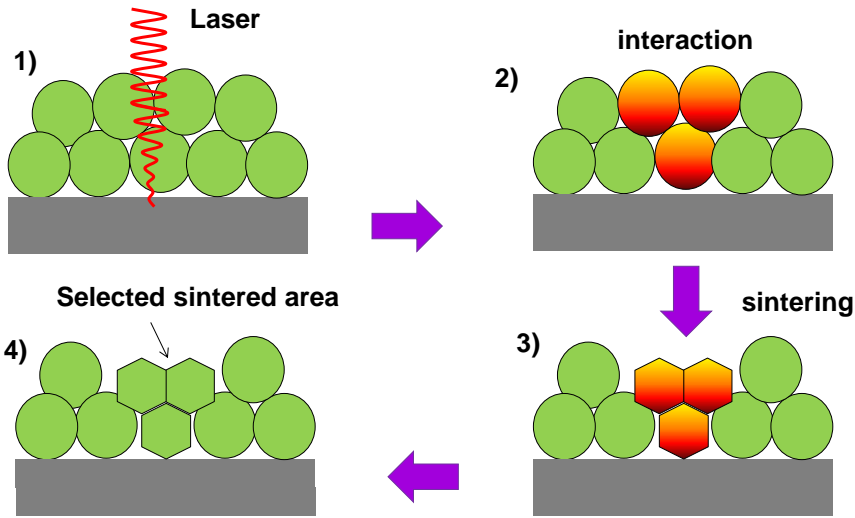
1) Flowability of powder

Mobility from “powder supply” to “build platform” using Recoater arm. (grain size, shape ...)

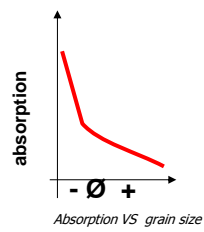
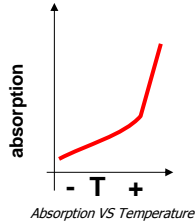
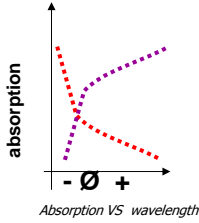
2) Laser-powder Interaction

Powder need to be melted or sintered (thermal properties of material, grain size, laser-mater interaction ...)

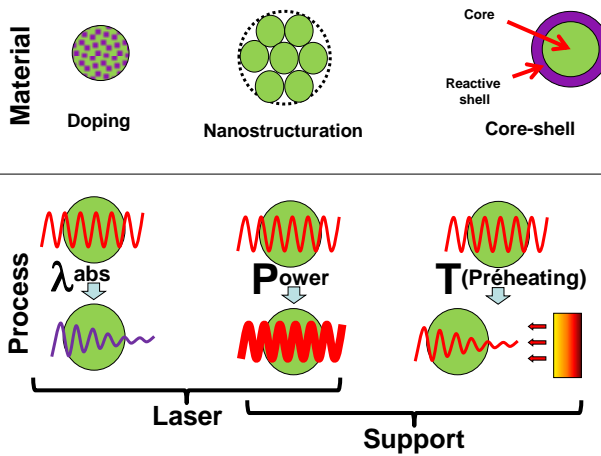
2



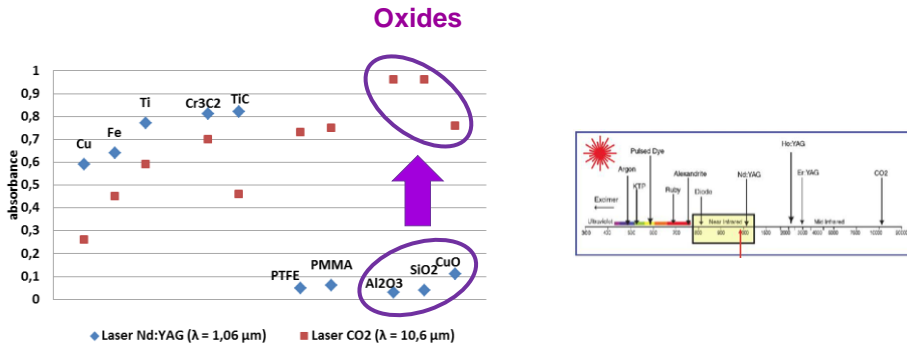
How to increase absorption of Powder and decrease absorption of support ?



How to increase absorption of powder ?



- Using different machines/lasers in order to sinter ceramics



SLS of Ceramic EOS M250 XT – Laser CO₂

Laser wavelength (CO₂) : 10,6 μm

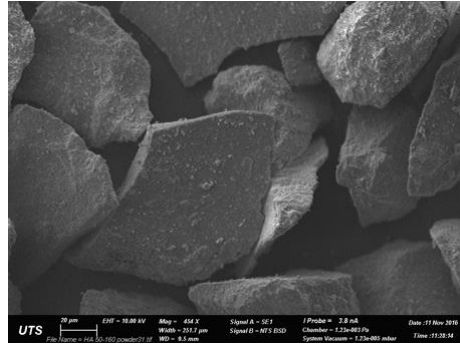
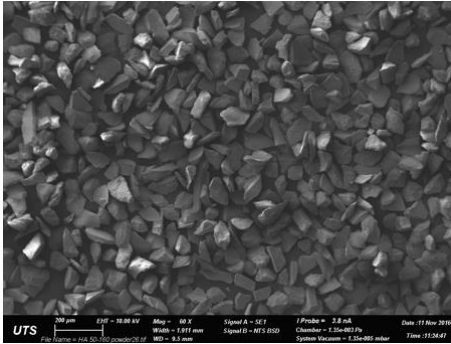
Power max: 240 W

Scanning speed: 50-5000 mm/s

Support : Titanium or Stainless steel

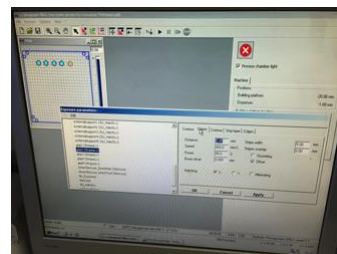


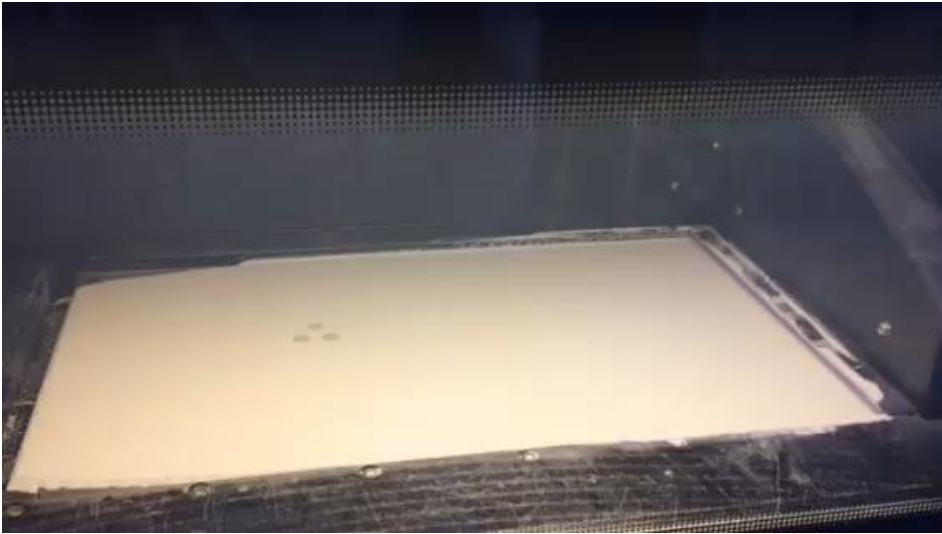
Hydroxyapatite powder
 $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$
 $50 \mu\text{m} < d_{\text{particules}} < 160 \mu\text{m}$



Parameters:

- Puissance laser
- Scan speed
- Layer Thickness
- Hatch Distance
- Lasing patterning
- Support (Yes/No)
- Multi-lasing (Yes/No)
- Material (Powder/Support)



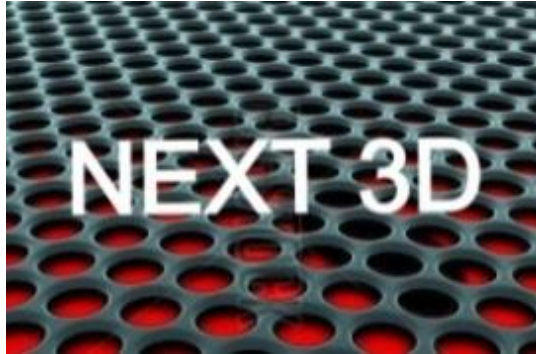


Parameters :

- ✧ TA6V support
- ✧ $[O_2]_{\text{gaz}} < 1,5 \%$
- ✧ Support Temperature = 80°C
- ✧ Strategy « external supports »
- ✧ Layer Thickness = 100 μm
- ✧ Power = 85, 90 or 95% (204 à 228 W)
- ✧ Scan speed = 80 or 100 mm/s



External supports ? → Lattice structures supports

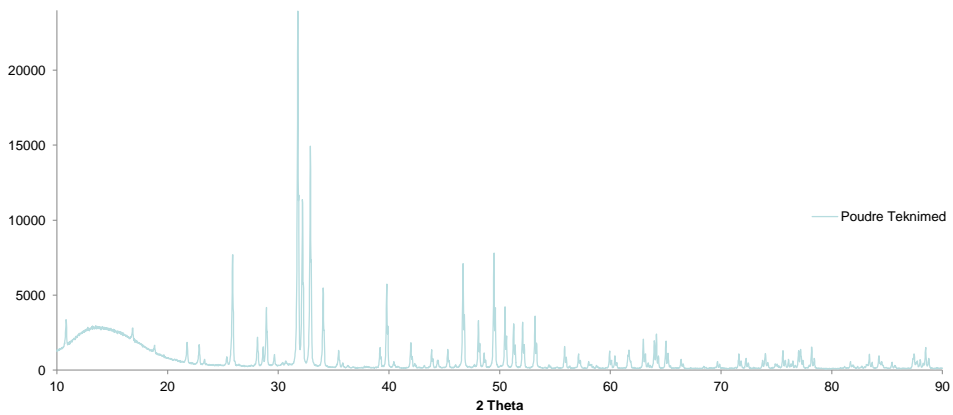


Decrease support absorption



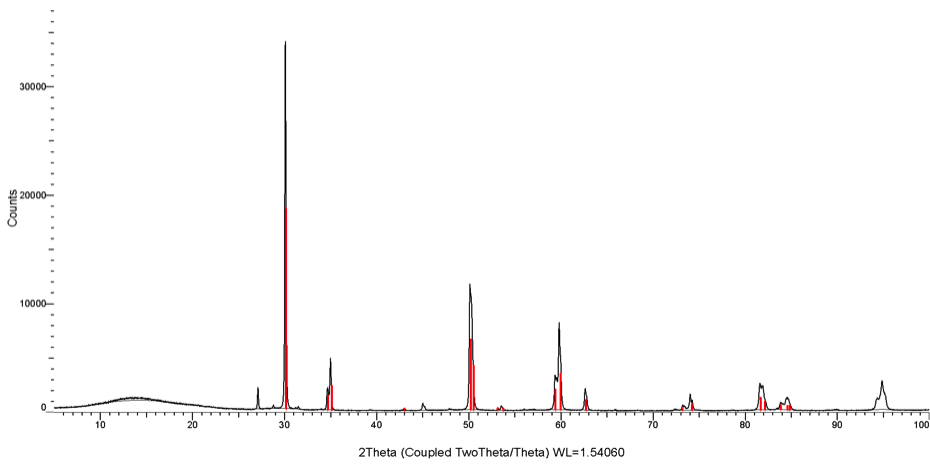
IP protections action(s)

XRD powder:

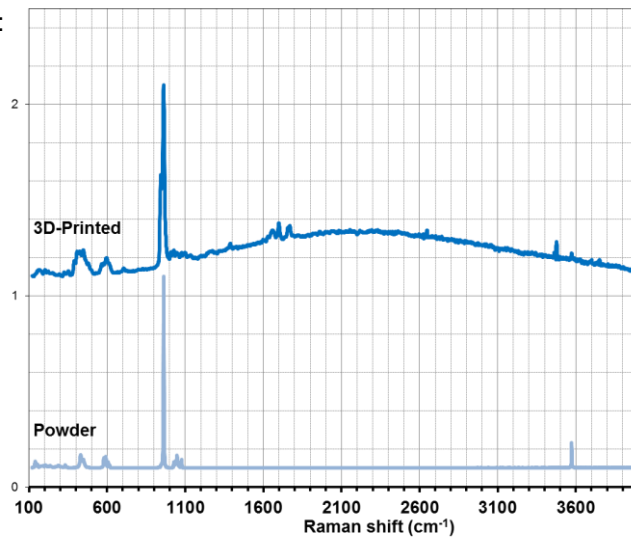


XRD sintered pellets:

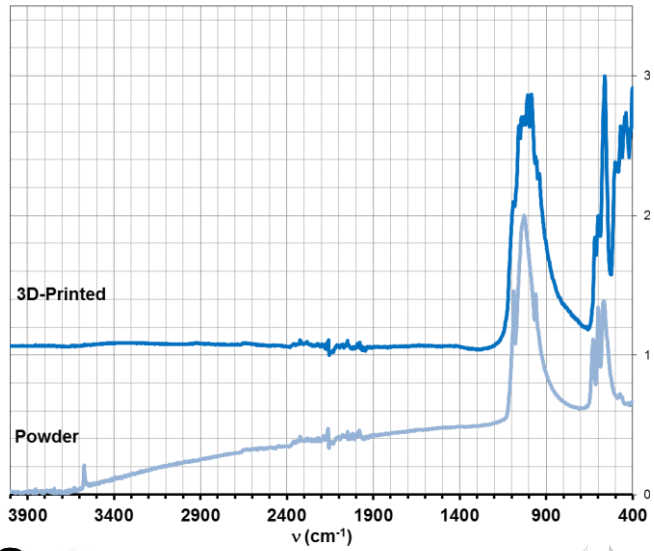
[best match = $\text{Ca}_4(\text{PO}_4)_2\text{O}$]



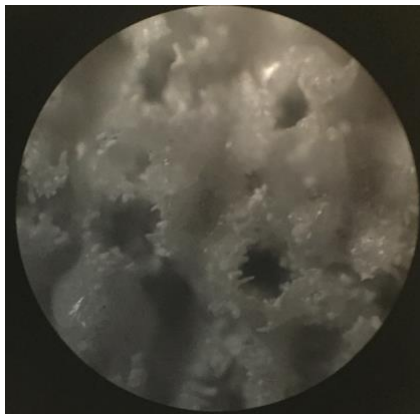
Analyse Raman :
(633nm) UTS



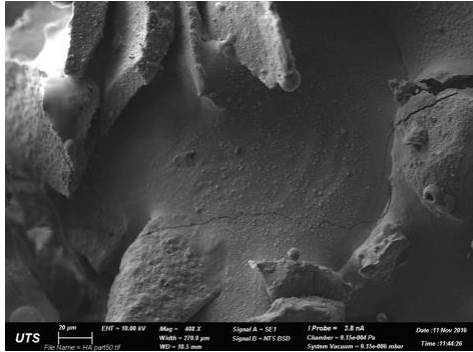
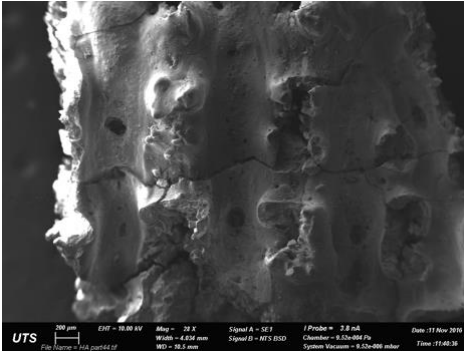
Analyse FTIR :
(ATR) UTS



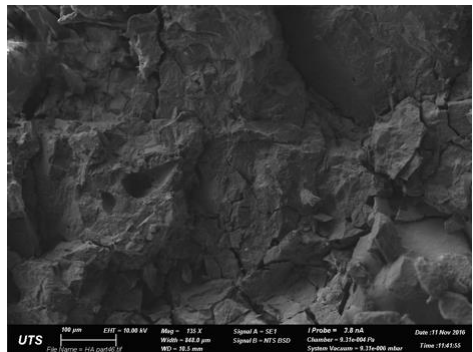
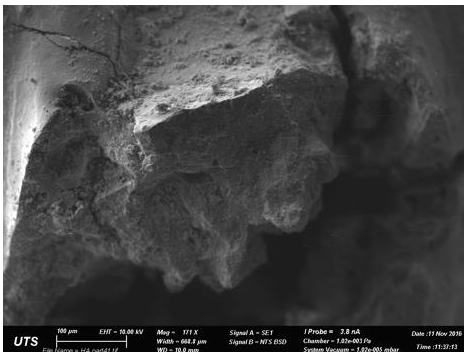
Top surface (Optical):



SEM, Top surface :



SEM, Fracture surfaces :



Conclusion :

- ✧ 1st SLS samples of HAP without doping
- ✧ Wavelength (CO₂)= 10.6 μm
- ✧ Strategy « external supports »
- ✧ IP protection action

- ➔ Optimization is required
- ➔ 1 Review article on 3DP of Ceramics

