3DOptic™ - Optimized Optical Substrates

Freeform days at Marseille – 2017

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GLOBAL SOLUTIONS FOR CERAMIC 3D PRINTING

- CERAMAKER 3D printing production line
- 3DMIX, ceramic feedstock
- On demand 3D printing production service
Leader in ceramic 3D printing

3DCeram a unique know-how for ceramic 3D:
- 2005: Start of On demand production
- 2010: 3Dceram made his first Ceramaker
- 2015: Launch of CERAMAKER 900,
- 2016: CERAMAKER 100 and printing lines and associated services,
- 2017: 3DMIX ceramic pastes on demand formulation dedicated to CERAMAKER printers
- 2017: New releases at Formnext...
Scientific environment

3DCeram is located in Limoges at the heart of scientific ceramic know how:

- CNRS, technical centers,
- About 150 scientists and PHD working on ceramic material and process,
- Engineer schools
A break through technology

Stereolithography applied to advanced ceramic
Ceramic 3D printing process

- Two steps process: printing and firing
- CERAMAKER additive manufacturing line
3D Printing Sequence

- 3DMix paste
- 3D printing with CERAMAKER
- Debinding
- Sintering
- Lazering
- Z down
- Layering
Ceramic Additive Manufacturing
3DOptic™ - Optimized Optical Substrates

- Custom-made ceramic optical substrate
- Dimensions: Ø250x100mm (Extended to Ø500x300mm Q4 2018)
- New way to design a mirror
  - Semi-close back structure
  - Integrated interface
  - Conformal ribs
- Next generation of instruments
  - Compact solution with integrated functions (thermal insulator, cooling channel...)
  - Limitation of mechanical & thermal interfaces
  - Integration of the optical function like a structural device
3D printing is only one step of the manufacturing process.

- Success depends on the expertises of 3 domains, not only 3D printing.
Multi-material integration:
- Combining high performance ceramic mirror and lightweight metal structure
- Ultra-stable: low thermal expansion (very close CTE)

Integrated bipod:
- Easier assembly operation
- High compactness

Integrated M2:
- Easier assembly operation
- High compactness

Optimized compliant mechanism:
- Made by 3Dprint in Ta6V
- Easy integration on the platform
3DOptic™ - Benefits

Ceramics 3D printing is a way to propose breakthrough design and improvements on both technical and business aspects.

**Technical improvements**
- Mass/stiffness ratio optimization (3D printed rib thickness limit at 0.2mm; machining at 1mm)
- New mechanical & thermal functions such as sealed channel or compliant mechanism
- Ability to only print material needed (avoiding the 90% material removal)

**Business improvements**
- Strong lead time decreasing by limiting manufacturing steps
- Design to print capability (custom-made without extra cost)
- Better risk management (breakage risk associated with manufacturing time)
Materials – 3DMiX

3DMix maturation process
- MRL1 – Study of the ceramic formulation
- MRL2 – Settings of the sintering
- MRL3 – Optimization of the paste into the 3Dprinter
- MRL4 – Testing on complex batch

Fully developed materials
- Alumina
- Zirconia
- HAP

On-going developments
- Si3N4
- ALN
- Cordierite

Future developments
- SiC
- Composite metal/Ceramic
Additional benefits

Quilting reduction

- Integrated polishing support
- Homogenous stiffness of the optical surface
- Reducing the time of polishing

Process

- Preparation of the CAD File
- Direct printing of the support with the mirror
- Same process of firing
Cooled substrate with internal ducks

Standard design for cooled optic
- The thermal function is made by an additional device like a copper strap or a brazed parts
- Not easy to manufacture and assembly (some interfaces)
- Optical error budget shall take into account some thermo elastic perturbation (CTE mismatch)

3D printing design
- 3D printing is able to manufacture conformal ducks in an optical substrate
- The cooling thermal function is integrated to the mechanical ribs
- Compact and lightweight solutions
Benefits for Freeform optics

Project Abstract
- Use of 3D printing to manufacture an optical substrate with the lightweighting, the freeform blank surface and integrated functions like the bipod.

Objectives
- Provide a “Ready to Polish” optical blank,
- Reducing of the manufacturing risk
- Increase the lead time of the optical blank

Work in progress
- Measure of surface deformation according to some process parameters
- Fabrication of freeform sample
- Test of polishing for the step#3
3DOptic - New Development

- **Optimized lightweighting**
  - Substrate Ø250mm with Ad < 10 kg/m²
  - Close back structure with optimized pattern
  - Integration of lattice

- **Assembly process**
  - Brazing inserts and parts in Ta6V
  - Helicoil on 3Dprinted threaded hole
  - Gluing – design of channel for injection

- **Finishing**
  - Tumbling
  - Polishing (not optical and only plane sample)

- Optimized mirror test
- Thread & screw benchmark
- Brazing benchmark
- Polishing test
Merci!

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