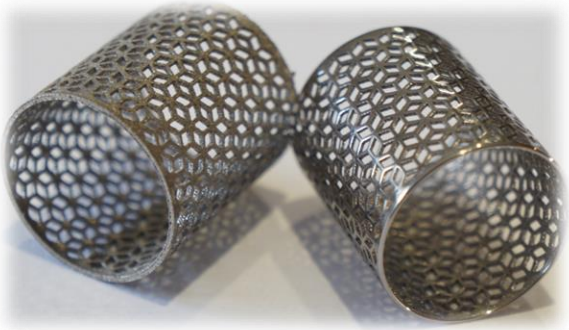
Politechno
La passion de la finition

# Journées Traitements et parachèvements de pièces issues de fabrication additive

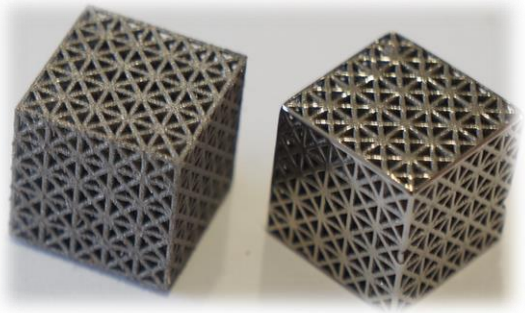
## Multi process post processing treatment of high value metal additive manufacturing components

## Gamme de parachèvement multi-procédés de pièces à fortes valeurs ajoutés issues de fabrication additive métallique



COLMAR – 01/12/2022

Politechno
La passion de la finition



# Summary

- Presentation of Politechno company
- Overview of the surface finishing technologies
- Focus on specific technologies / Innovative technologies
- Case studies
- Questions

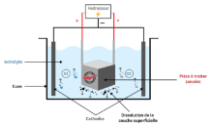
# Presentation of Politechno company


| Politechno | Technologies de Finition de surfaces | France

Politechno
La passion de la finition

- Offre de services
  - Conseil – Ingénierie - Expertise
  - Mise au point – Industrialisation
  - Optimisation de gammes
  - Formation
- Offre d'équipements
  - Tribofinition - Centrifugation
  - Sablage – Microbillage
  - Médias et consommables
  - Equipements périphériques
  - …

# Overview of the surface finishing technologies

- Finishing surface processes
  - Machining 
  - Abrasives (rigid) 
  - Abrasives (free) 
  - Plastic deformation 
  - Chemical 
  - Electro Chemical 
  - Thermal 

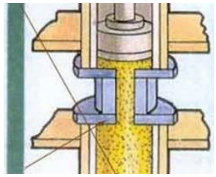
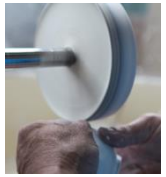
# Overview of the surface finishing technologies

- Finishing surface processes
  - Machining
    - Milling
    - Turning


  - Abrasives (rigid)
    - Grinding

  - Abrasives (free)
    - Mass finishing
    - Sandblast
    - AFM
    - Brushing
    - Water jet

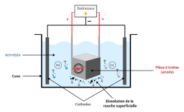


  - Plastic deformation
    - Shoot peening
    - Burnishing
    - Magnetic tumbling


  - Chemical
    - Chemical machining
    - Chemical polishing

  - Electro Chemical
    - Electro polishing
    - Plasma polishing



  - Thermal
    - Laser polishing
    - Cryogenic deburring
    - Thermical deburring

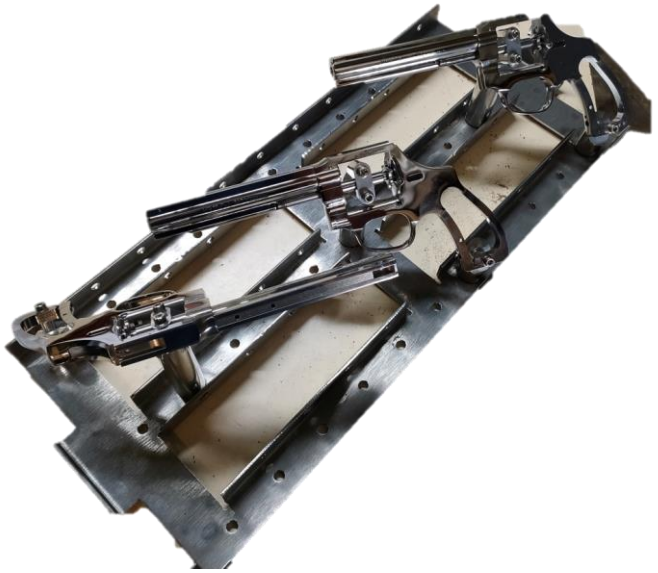


# Focus on specific technologies / Innovative technologies

## ➢ Optimization of « standard » technologies

- Abrasion (abrasifs libres)
  - Mass finishing → High speed centrifugal polishing machines
  - Sandblast
  - AFM
  - Bruching
  - Water jet
- Déformation plastique
  - Shoot peening
  - Burnishing
  - Magnetic tumbling
- Chimique
  - Chemical machining
  - Chemical polishing
- Electrochimique
  - Electro polishing
  - Plasma polishing
- Thermique
  - Laser polishing
  - Cryogenic deburring
  - Thermical deburring


force centrifuge haute vitesse | Politechno



RIFATEC GMBH - High Speed centrifugal systems

# Focus on specific technologies / Innovative technologies

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- Thermique
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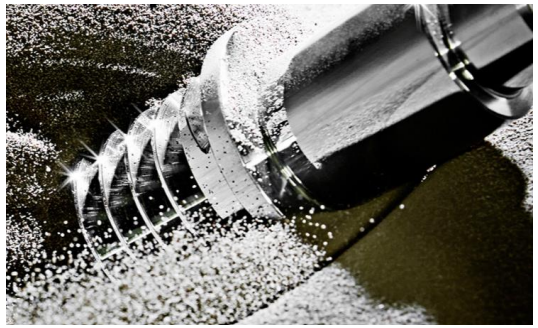
  - Cryogenic deburring
  - Thermical deburring

Stream finish machine for large parts


*Source: OTEC*



SF-HP - OTEC Präzisionsfinish GmbH

# Focus on specific technologies / Innovative technologies

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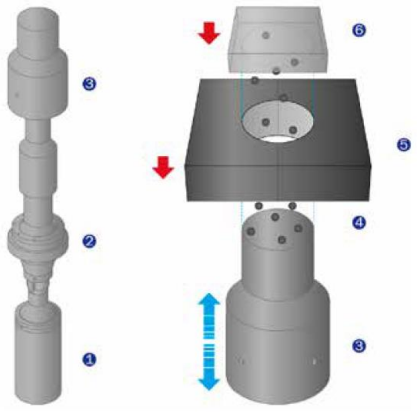
Ultrasonic shot peening

Exemple de machine monoposte de production

**PRINCIPE DE LA TECHNOLOGIE STRESSONIC®**



1. Émetteur
2. Boosters
3. **Sonotrode :** Issu de notre générateur ultrasons de 20 kHz, l'émetteur piézo-électrique convertit le signal électrique sinusoïdal (fréquence ultrasonique) en un déplacement mécanique. Il est ensuite amplifié par une série de boosters et par la sonotrode (amplitude de vibration de 20 et 120µm).
4. **Média** : Seuls quelques grammes de billes sont nécessaires. Ces médias de haute qualité et sans défauts sont disponibles dans une large gamme de tailles et de matériaux.
5. **Enceinte** : L'enceinte est fabriquée en fonction de la géométrie de la pièce et de la zone à traiter. Les billes sont confinées dans l'enceinte.
6. **Pièce grenaillée**

**Cage intersomatique**

Grenaillage STRESSONIC® réalisé pour remédier à une problématique de tenue en fatigue dans le fond du rayon.

Contrainte maxi observée en surface: -700 mPa

*Source:*

*SONATS*
*EUROPE TECHNOLOGIES*

What is shot peening ? How does shot peening work ? | SONATS (sonats-et.com)

# Focus on specific technologies / Innovative technologies

## ➢ Optimization of « standard » technologies

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  - Electro polishing
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- Thermique
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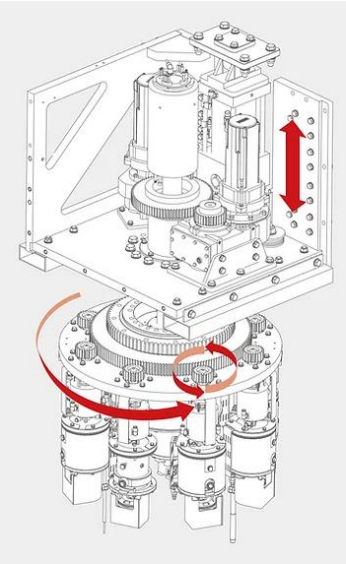
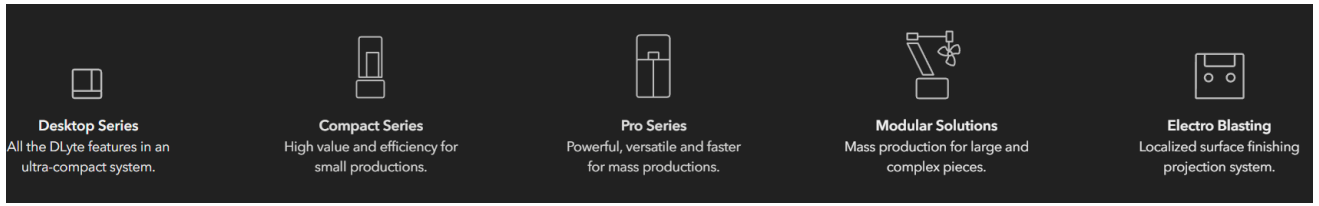
Dry Electro Polishing






*Source: GPA Innova*

DLyte Electropolishing

# Focus on specific technologies / Innovative technologies

## ➢ Optimization of « standard » technologies

- Abrasion (abrasifs libres)
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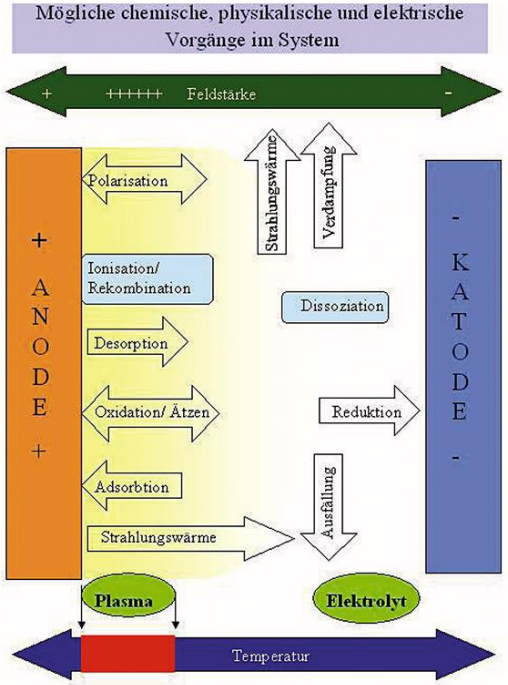
  - Chemical machining
  - Chemical polishing
- Electrochimique
  - Electro polishing
  - Plasma polishing
- Thermique
  - Laser polishing
  - Cryogenic deburring
  - Thermical deburring

Plasma Electro Polishing PEP

*Source: PLASOTEC*

[Plasmapolieren | Elektropolieren | Oberflächenveredlung - plasotec GmbH]




[Plasma Polishing Machine For Dental - YouTube]

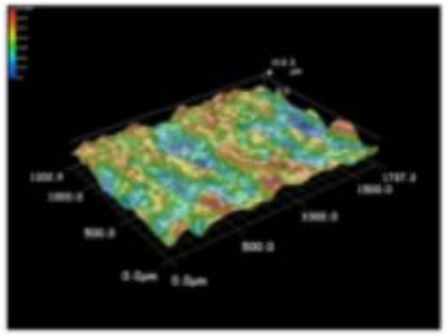
[ELECTROLYTE AND PLASMA PROCESSING (EPP) - proper time to glare! - Prometal]

# Focus on specific technologies / Innovative technologies

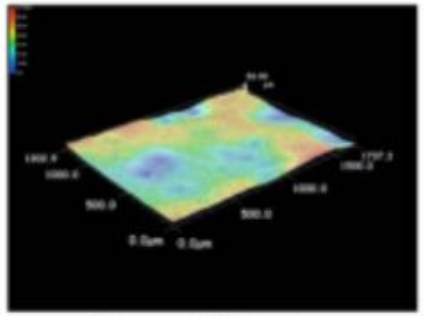
- Hybridation of « standard » technologies

- Abrasion (abrasifs libres)
  - Tribofinition
  - Sablage - microbillage
  - Abrasive flow Machining (AFM)
  - Toilage
  - Brossage
  - Polissage jet d'eau
- Déformation plastique
  - Granaillage - Shot peening
  - Martelage
  - Galetage
  - Trovalisation magnétique
- Chimique
  - Usinage chimique
  - Polissage chimique
- Electrochimique
  - Electro polissage
  - Ebavurage electrochimique
- Thermique
  - Polissage laser
  - Ebavurage cryogénique
  - Ebavurage thermique

ISF Process for Metal Superfinishing- REM Surface Engineering (remchem.com)



As-Built Surface

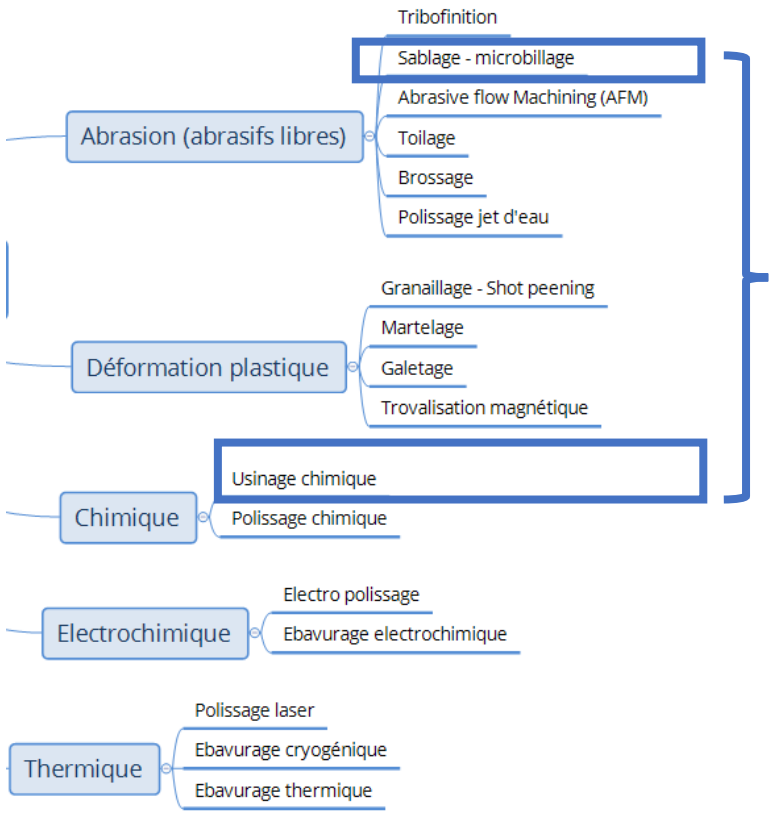


Extreme ISF® Surface

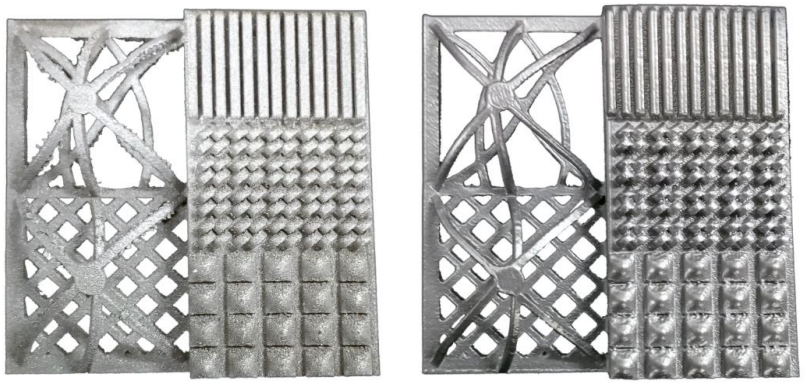
*Source: REMCHEM*

# Focus on specific technologies / Innovative technologies

- Hybridation of « standard » technologies



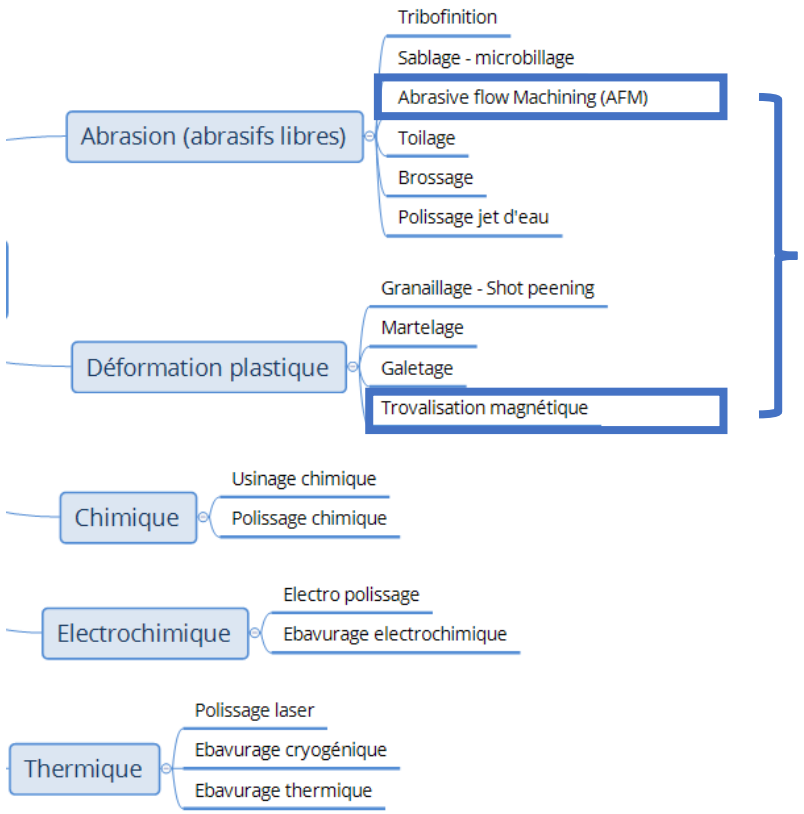

DECI Duo - PostProcess Technologies

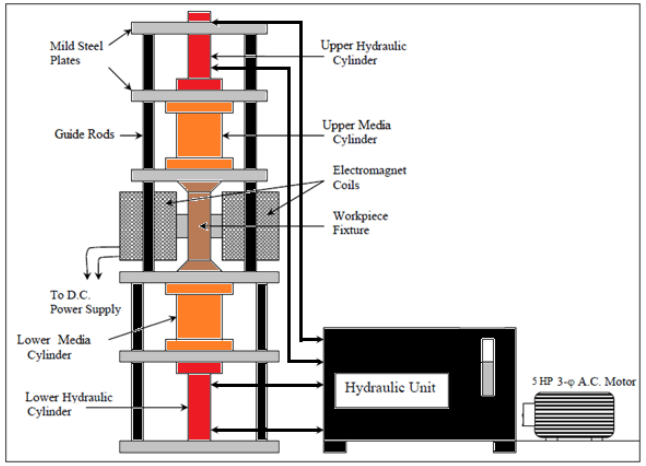
*Source: PostProcess technologies*

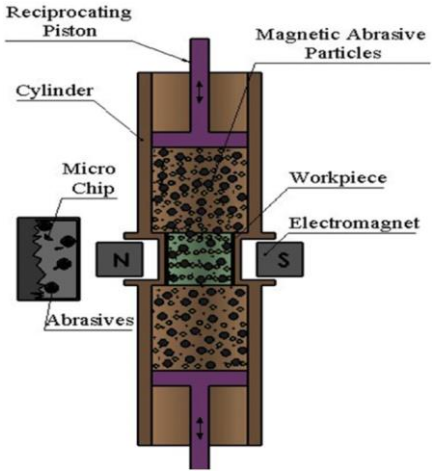
# Focus on specific technologies / Innovative technologies

- Hybridation of « standard » technologies




Schematic illustration of magnetic abrasive flow machining (MAFM) process | Download Scientific Diagram (researchgate.net)




Experimental Comparison of Abrasive Flow Machining and Magnetic Abrasive Flow Machining for Aluminium Tubes

Article · June 2018
DOI: 10.18231/2454-9150.2018.0410

CITATIONS 6 | READS 1,153

3 authors, including:

Palwinder Singh
Baba Banda Singh Bahadur Engineering College
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# Specificities of the additive manufacturing post process

- Technical and scientist studies / Projects and Industrial fair dedicates for surface finishing of AM parts

Fraunhofer FRA-19-24033_Surface Finish Study_Flyer_RZ.indd (fraunhofer.de)

IRT M2P Institut de Recherche Technologique Matériaux Métallurgie et Procédés
Clôture du projet AFTER ALM | IRT M2P (irt-m2p.fr)
Fabrication additive : l'IRT M2P lance le projet NEMO (NExt alM finishing prOcesses) | IRT M2P (irt-m2p.fr)

L'USINENOUVELLE Parachèvement des pièces par fabrication additive : état de l'art (usinenouvelle.com)

A3TS Traitements et parachèvements des pièces métalliques issues de facbrication additive - 3e édition - 10 ET 11 DECEMBRE 2019 — A3TS - L'association de traitement thermique et de traitements de surface

cetim Projet Thématique Transversal Finition des surface

DEBURRING EXPO Theme park - "AM Parts Finishing" – DeburringEXPO - Trade Fair for Deburring Technologies and Precision Surfaces (deburring-expo.de)

formnext Product groups - Formnext - Mesago

# Specificities of the additive manufacturing post process

- Technical and scientist studies / Projects and Industrial fair dedicates for surface finishing of AM parts

IRT M2P Institut de Recherche Technologique Matériaux Métallurgie et Procédés

IRT M2P | Expertise & Platforms | Working together | News & Media | Talents | Contact

## Travaux transverses

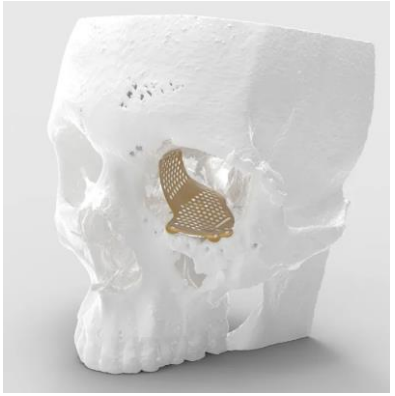
En complément des briques technologiques précédemment citées, des travaux transverses seront réalisés avec une attention particulière portée sur le développement de combinaisons de procédés, avec l'objectif d'atteindre des niveaux de rugosité très faibles (1 µm) sur des éprouvettes à géométrie complexe, tout en préservant leur intégrité géométrique. Par ailleurs, des travaux seront également mis en œuvre en vue d'évaluer la capacité des procédés de parachèvement à enlever les supports de fabrication et nettoyer les pièces après fabrication additive.

A terme, l'objectif du projet NEMO consistera à promouvoir des briques technologiques robustes indispensables pour le parachèvement des pièces issues de fabrication additive et de géométrie complexe. Par ailleurs, il visera à démontrer que ces procédés se présentent comme une solution viable pour le déploiement de la fabrication additive dans différents secteurs (aéronautique, naval, médical, etc.) et cela, pour différents acteurs de la chaine industrielle (donneurs d'ordres, fabricants, applicateurs).

En développant des procédés innovants jusqu'à TRL6 en vue d'un transfert industriel, NEMO soutiendra le déploiement de la filière de la fabrication additive vers les domaines industriels les plus exigeants et lui permettra d'être un levier d'innovation et de gain de compétitivité.

# Case studies

- Custom craniomaxillofacial implant
  - Project in partership with the following companies:
    - ADMIRABILES
    - 3D PRECISION SA
  - Material:
    - Titanium grade 2 – T40
  - Manufacturing process
    - Laser powder bed fusion
  - Aim:
    - Final roughness: Ra < 1 µm
    - No deformation of the geometry
  - Initial roughness:
    - Ra 6 µm – Rz 80 µm
  - Mains contraints :
    - Fragility of the part (thin part)



# Case studies

- Custom craniomaxillofacial implant
  - If we don’t think about multi process / multi technologies manufacturing…

✓ Centrifugal polishing technology:

Machine:

Process principe :

Chips :

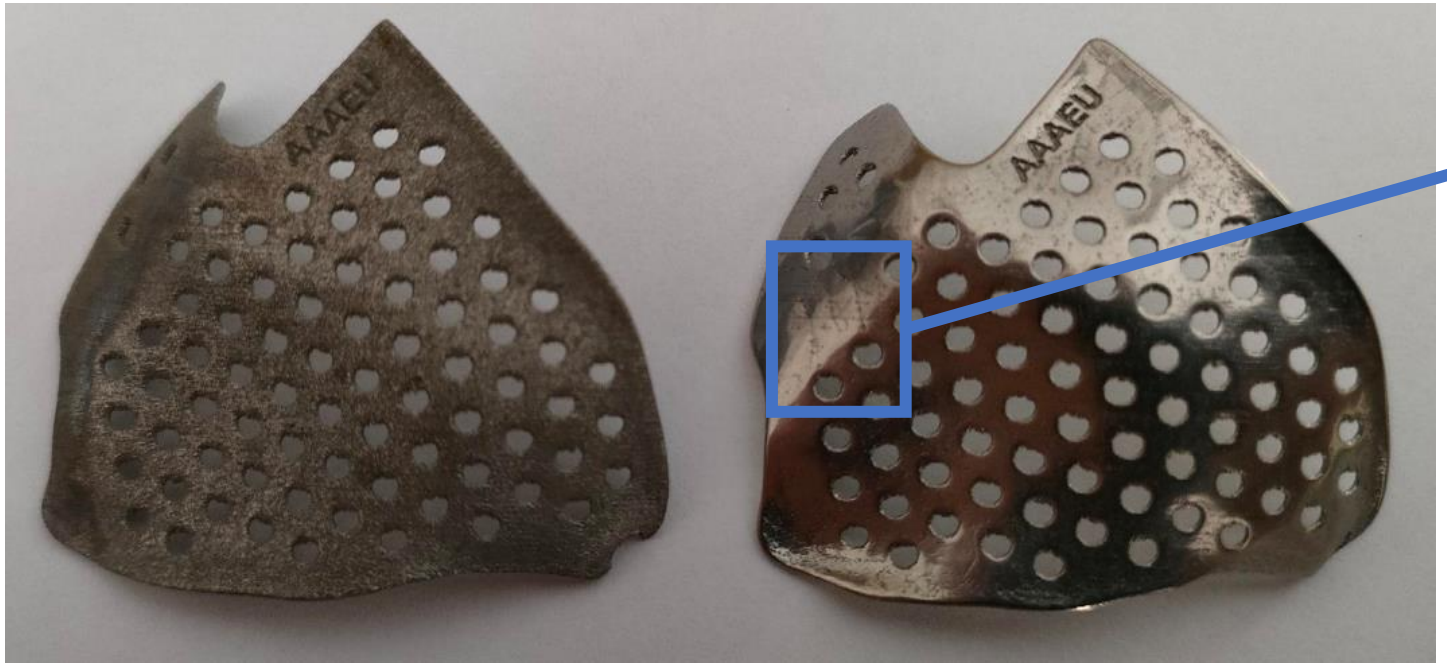
Time :

2x 1 hour

# Case studies

- Custom craniomaxillofacial implant
  - If we don’t think about multi process / multi technologies manufacturing…

✓ Centrifugal polishing technology:

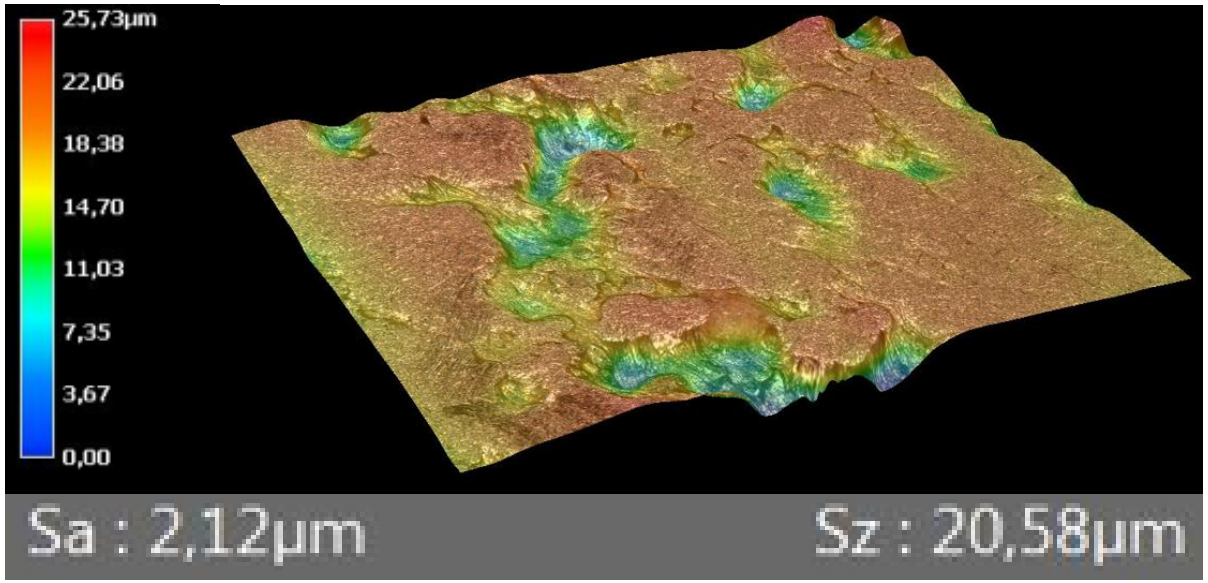


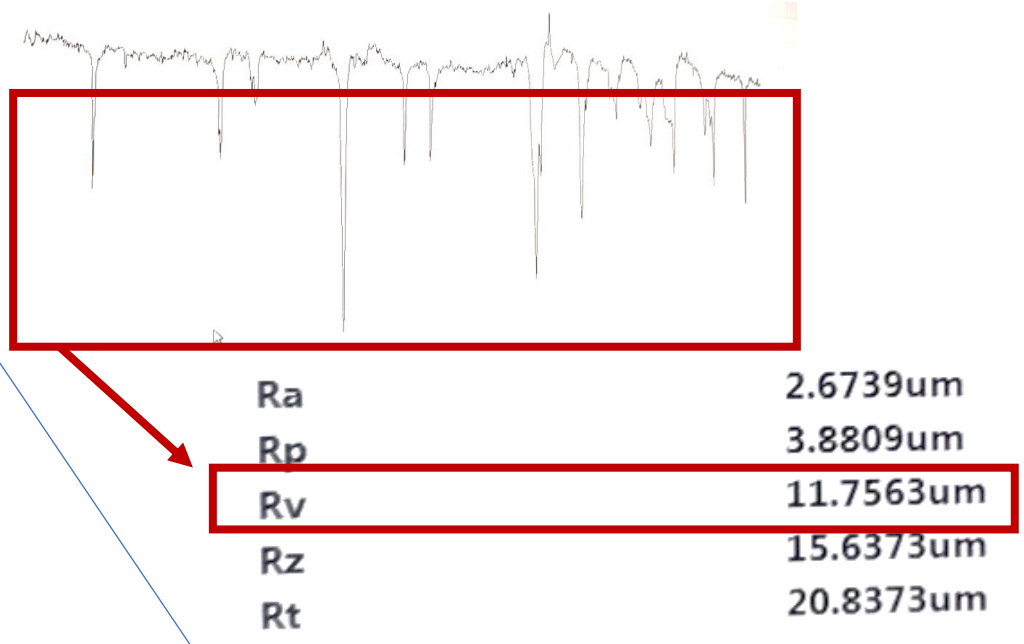

# Case studies

- Custom craniomaxillofacial implant
  - If we don’t think about multi process / multi technologies manufacturing…

✓ Centrifugal polishing technology:

Roughness on critical area … :



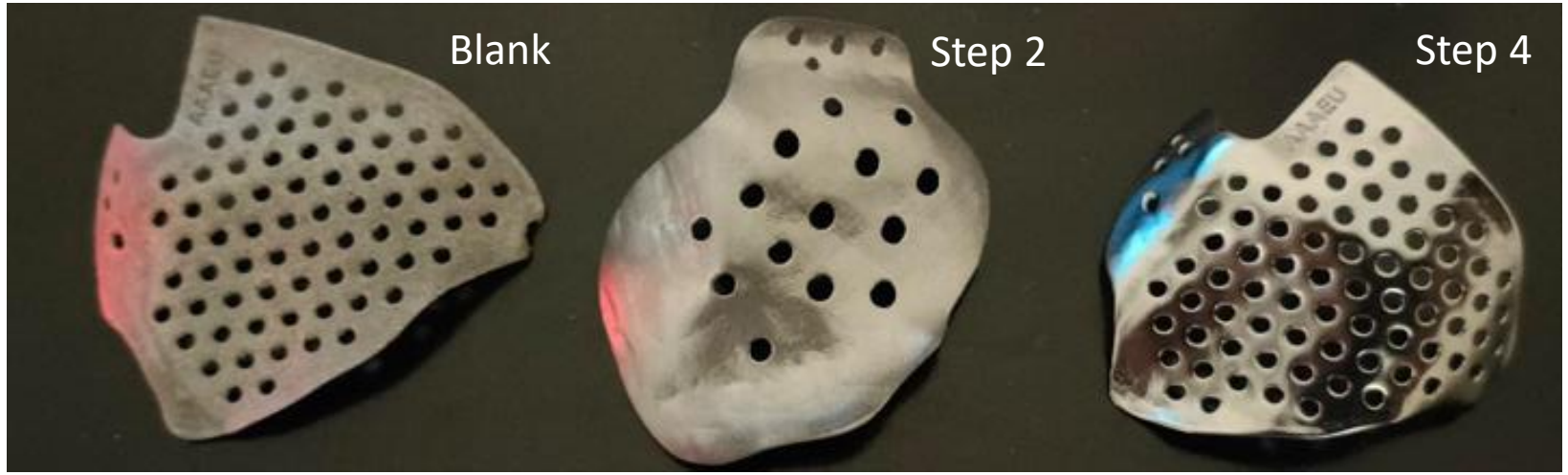




… Due to the Rv roughness criteria

# Case studies

- Custom craniomaxillofacial implant
  - … If we take advantage of each technologies and if we split the limits:

- ✓ Step 1:
  - ✓ Centrifugal polishing
  - ✓ Time: 1 hour
  - ✓ With abrasives medias
    - ✓ PC1-10
- ✓ Step 2:
  - ✓ Pressure sandblast step
  - ✓ Time: 2 minutes
  - ✓ Pressure: 2,5 bars
  - ✓ With Oxyde Zirconia beads
    - ✓ Size 250 µm
- ✓ Step 3:
  - ✓ Centrifugal polishing
  - ✓ Time: 0,5 hour
  - ✓ With fine abrasives medias
    - ✓ PC7-10
- ✓ Step 4:
  - ✓ Magnetic tumbling
  - ✓ Time: 1 hour
  - ✓ With SS pin medias
    - ✓ Dia 0,2 x 4 mm



# Case studies

- Custom craniomaxillofacial implant
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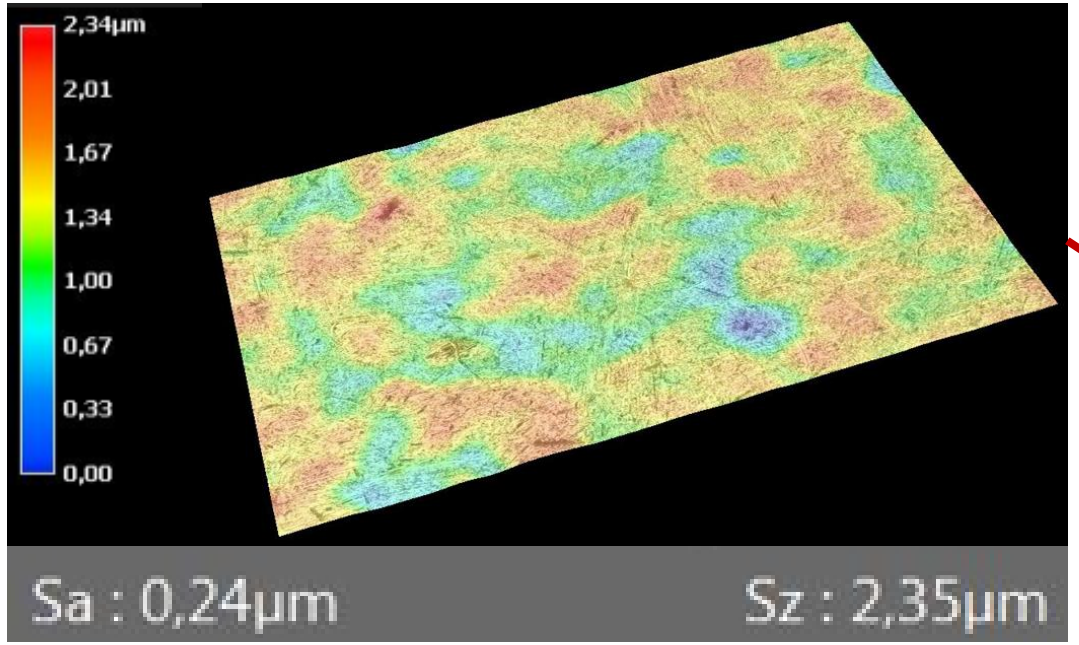
# Case studies

- Custom craniomaxillofacial implant
  - … If we take advantage of each technologies and if we split the limits:




| | |
|---|---|
| Ra | 0.4073um |
| Rp | 0.7453um |
| Rv | 1.9497um |
| Rz | 2.6951um |
| Rt | 5.1308um |

# Case studies

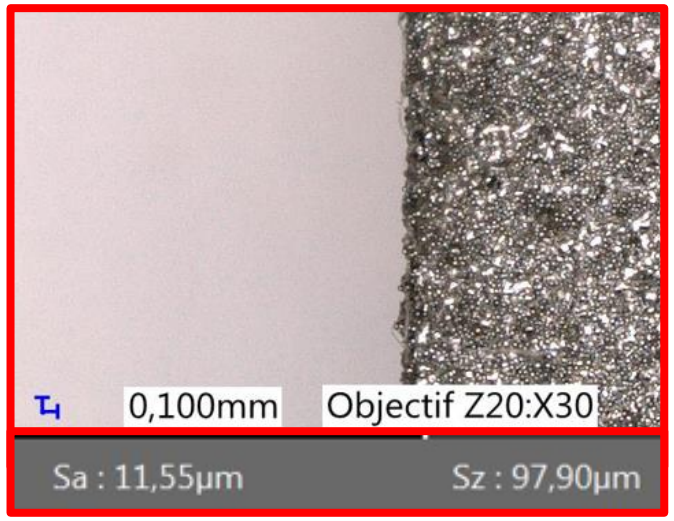
- Titanium grade 5 structural part made from topological optimization
  - … If we take advantage of each technologies and if we split the limits:

| Chemical machining | Zirconium beads pressure sandblasting | High speed centrifugal polishing<br>WET PROCESS<br>High density aluminide medias | High speed centrifugal finishing<br>DRY PROCESS |
|---|---|---|---|
| Surface roughness homogénéisation<br>Suppression of the Alpha case layer | Surface roughness preparation:<br>Residual stresses:<br>Compression – 600 MPa | Diminution of the global roughness<br>From Ra 6 µm to Ra < 1,8 µm | Diminution of the global roughness<br>From Ra 1,8 to Ra < 0,9 µm |

- Project in partership with CETIM

Crédit : Cetim

Blank surface on upskin area



# Case studies

- Titanium grade 5 structural part made from topological optimization
  - … If we take advantage of each technologies and if we split the limits:

**Chemical machining** → **Zirconium beads pressure sandblasting** → **High speed centrifugal polishing WET PROCESS High density aluminide medias** → **High speed centrifugal finishing DRY PROCESS**

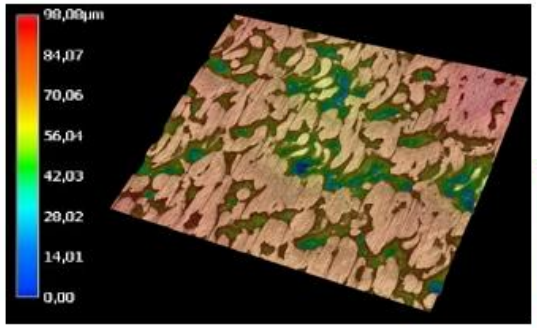
Surface roughness homogénéisation
Suppression of the Alpha case layer

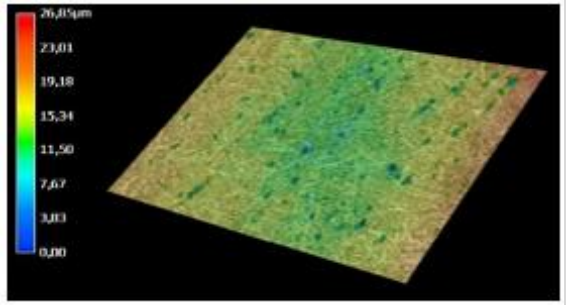
Surface roughness preparation:
Residual stresses:
Compression – 600 MPa

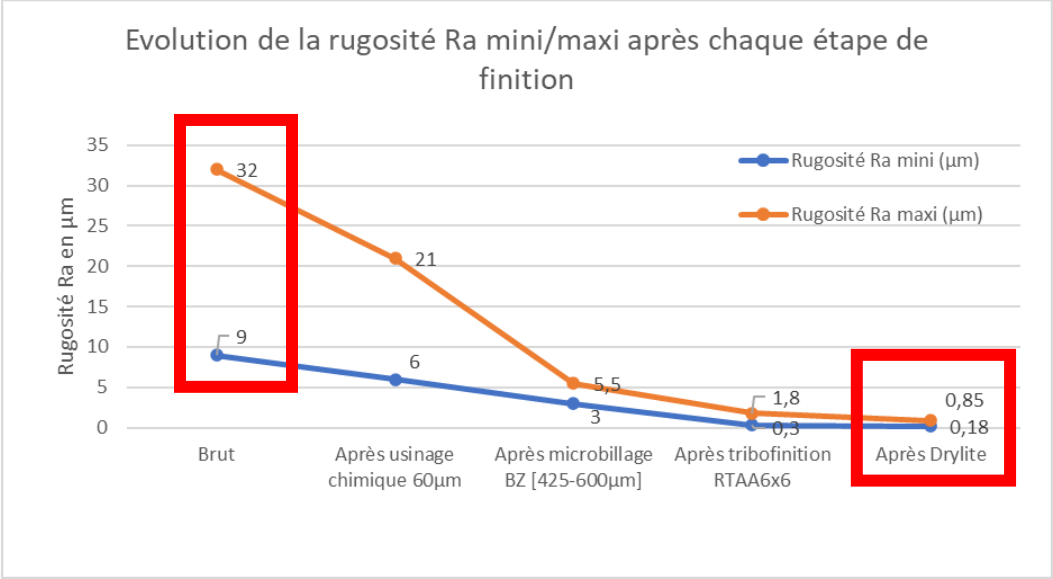
Diminution of the global roughness
From Ra 6 µm to Ra < 1,8 µm

Diminution of the global roughness
From Ra 1,8 to Ra < 0,9 µm

- Project in partership with CETIM



# Questions

# Remerciements

ASSOCIATION FRANÇAISE DU TITANE
The French Titanium Association

A3TS

IRTM2P

ad mirabiles

3D PRECISION SA

cetim

CUSTOMERS

# Contact

**Martin JAY**
POLITECHNO
01 Rue de Bebieux
42160 BONSON
Mob: +33 (0)6.19.15.82.14
mail: contact@politechno.fr
site internet: www.politechno.fr

Politechno
La passion de la finition