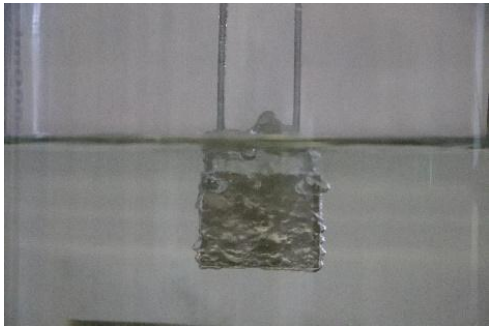
High Gloss and Sterile Surfaces on Complex Shaped Parts Using PeP

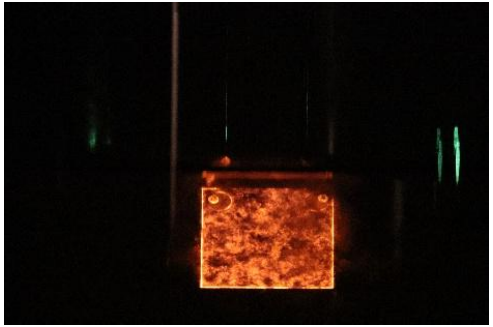
AMTOPUS
ADVANCED MANUFACTURING

3rd Czech-German Business Meeting - Ostrava

AMtopus GmbH & Co.KG | Falko.Boettger-Hiller@AMtopus.de | Tel.: +4917623252450 | Dr. Falko Böttger-Hiller

PLASMA-ELECTROLYTIC POLISHING





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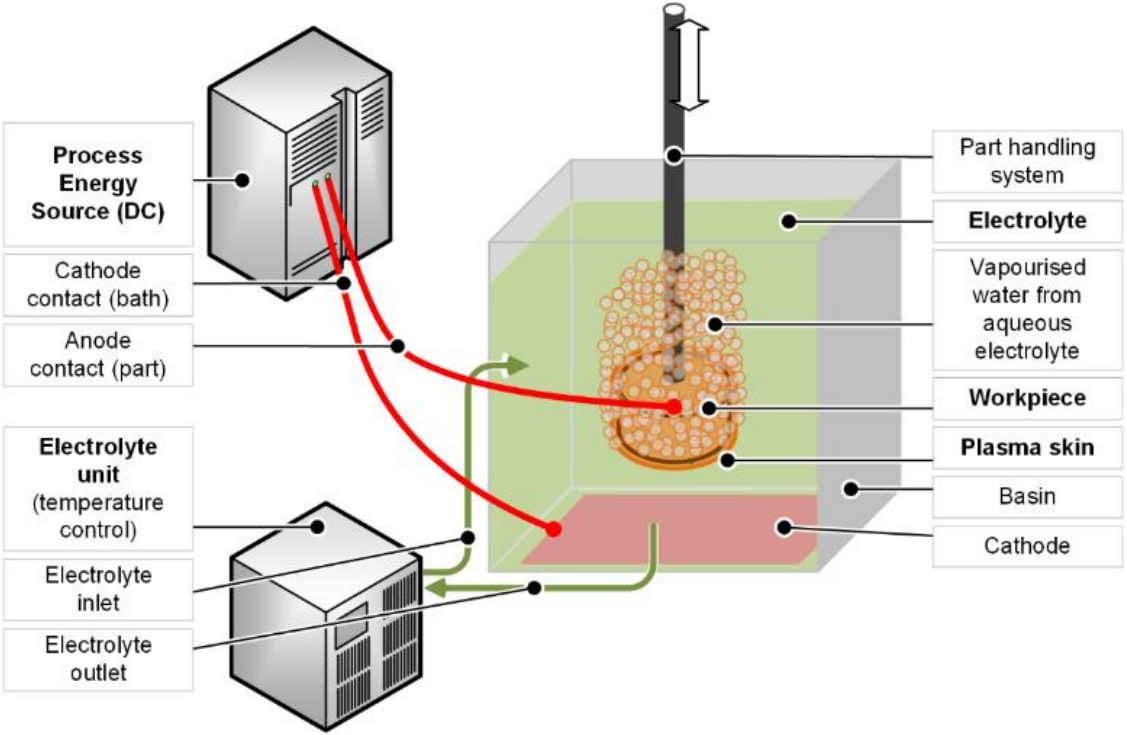

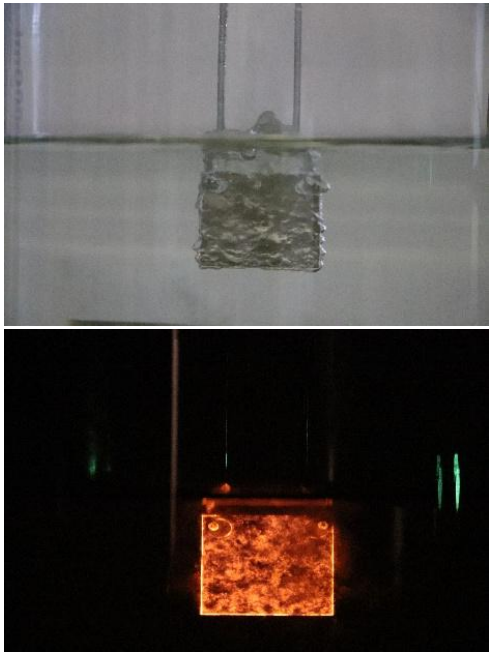

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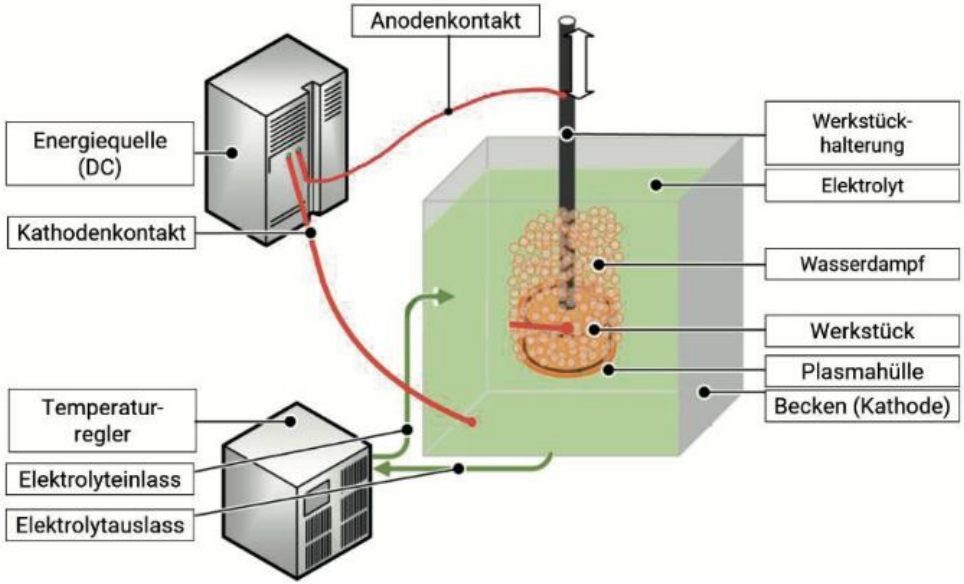

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PLASMA-ELECTROLYTIC POLISHING

- conductive materials
- environmental friendly
- short processing time
- technology suitable for very thin layers

- electrolyte plasma
- aqueous electrolyte
- 180–400 V
- 75–90 °C

- decreasing roughness
- inhibited oxide formation
- increasing gloss
- rounded edges

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APPLICATION: APPEARANCE

Welded parts

- Material: steel
- Target: smooth surface, gloss and shine increase
- Pre-treatment: nil

> Removal of weldline colors

> Gloss enhancement and roughness decrease

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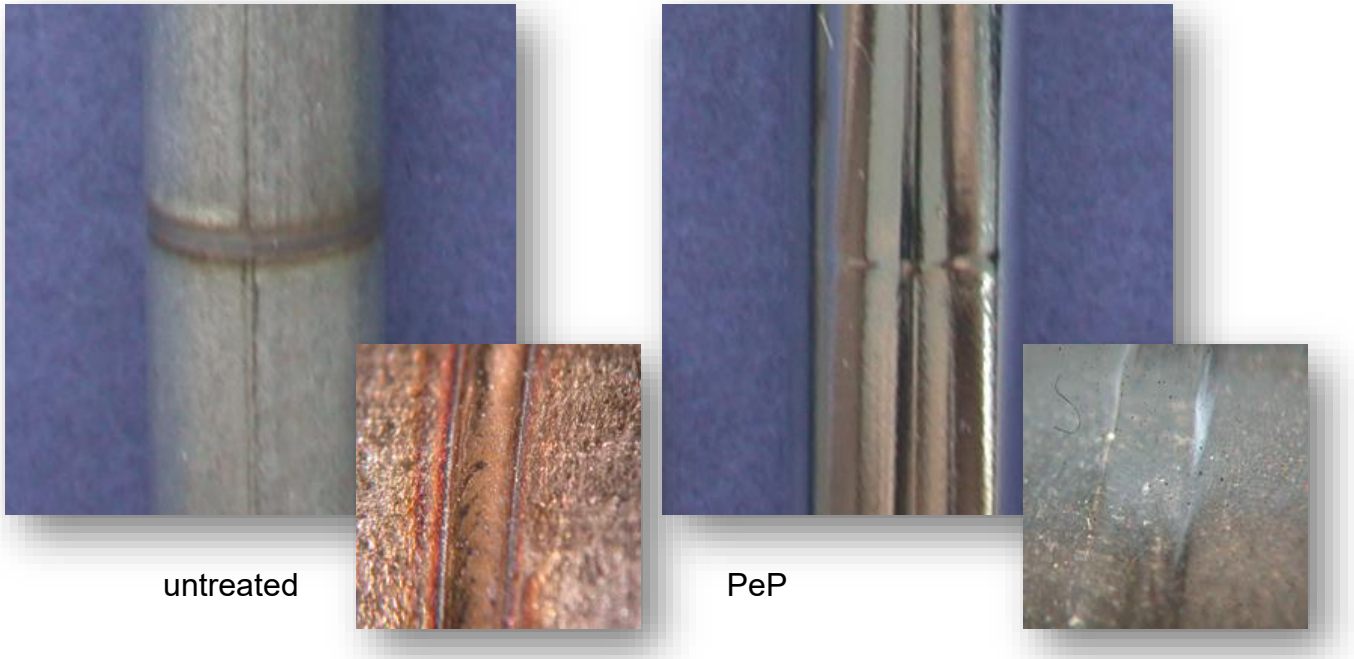
APPLICATION: APPEARANCE

Cleaning a laser welded tube



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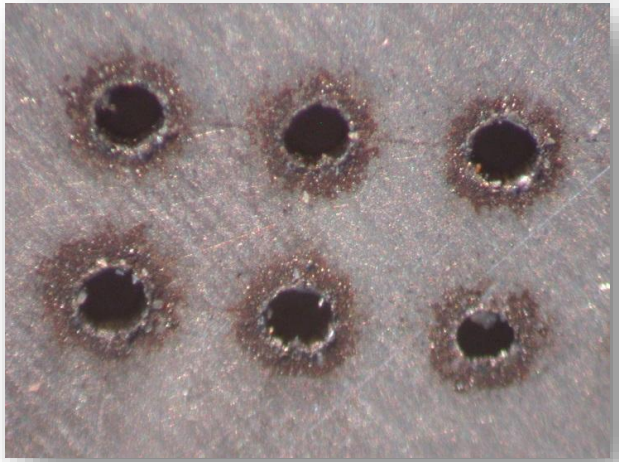
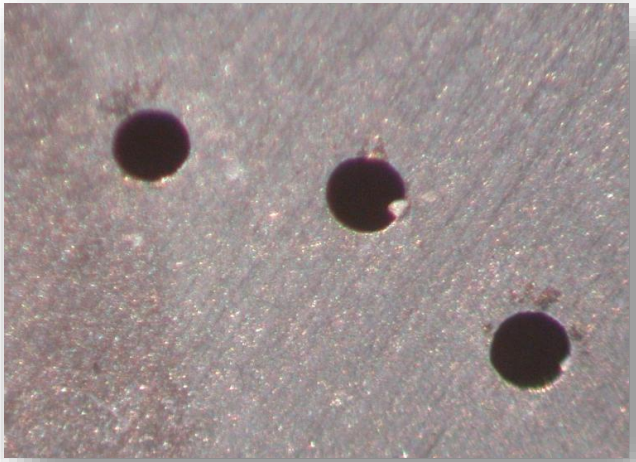
APPLICATION: APPEARANCE

Deburring holes created by a microlaser



untreated



PeP (20 seconds)

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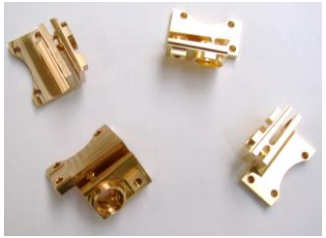
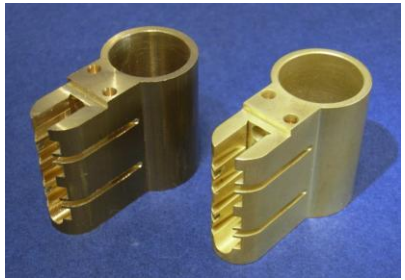
APPLICATION: APPEARANCE

Copper parts (cast/milled)

- Material: copper
- Target: gloss increase
- Pre-treatment: nil

> Significant gloss increase

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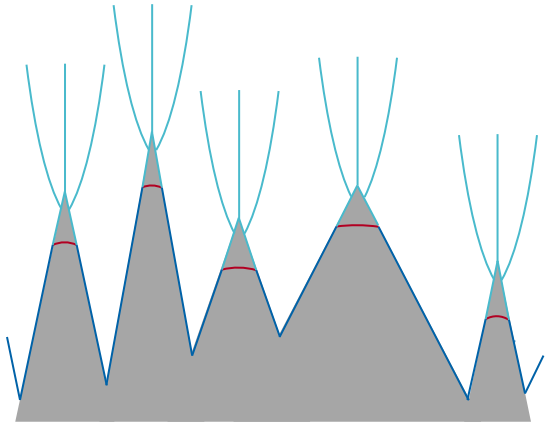
SURFACE MACHINING PROGRESSION IN PeP



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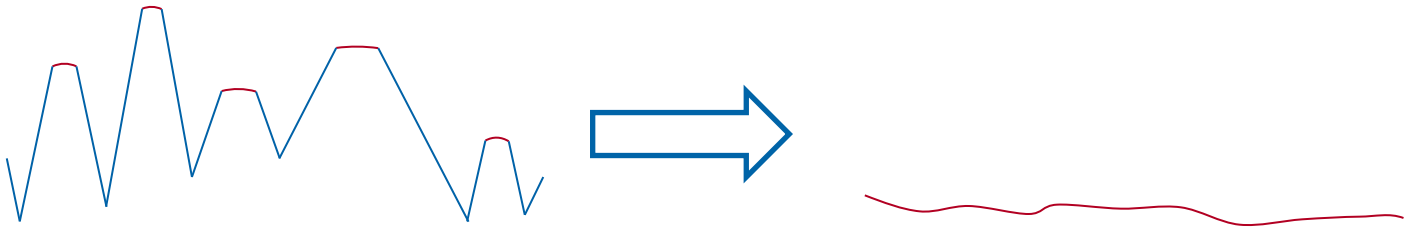

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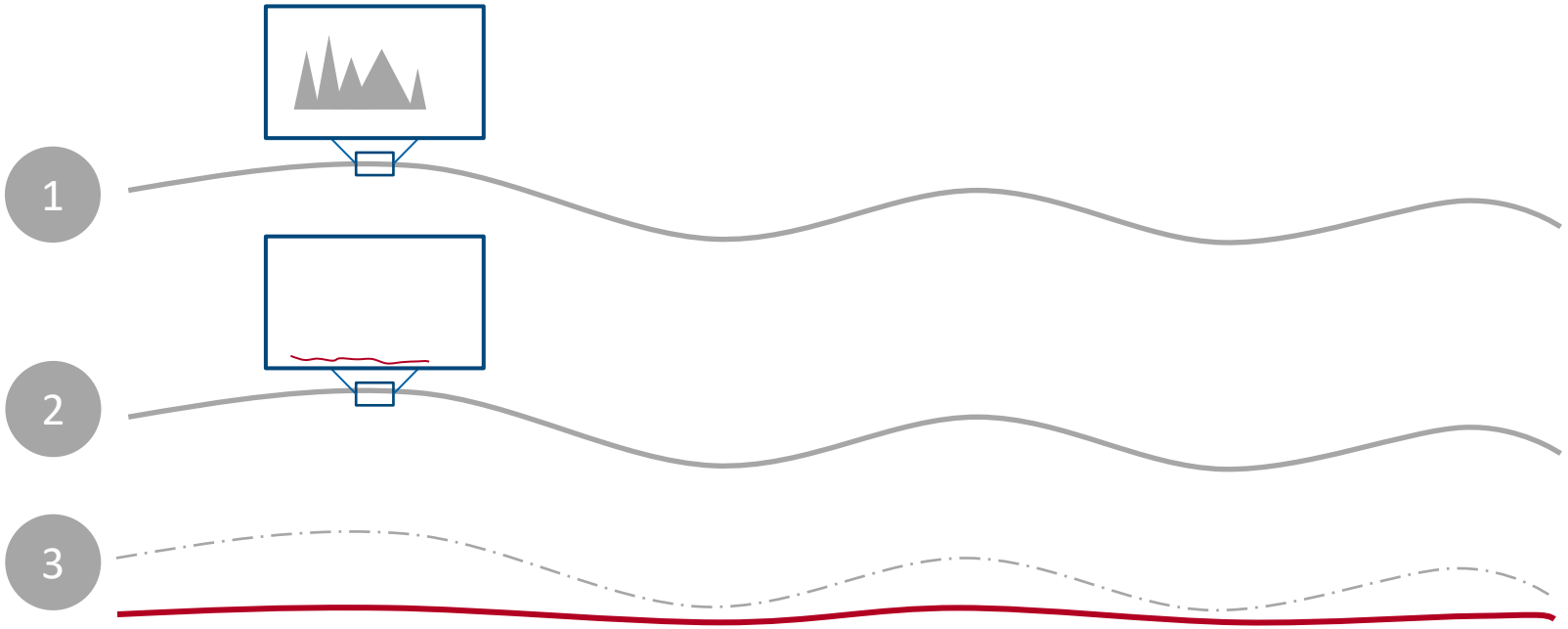
SURFACE MACHINING PROGRESSION IN PeP



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AM PART PEP

AM (SLM) part

- Material: 316l steel
- Target: smooth surface, gloss and shine increase
- Pre-treatment: corundum blasting

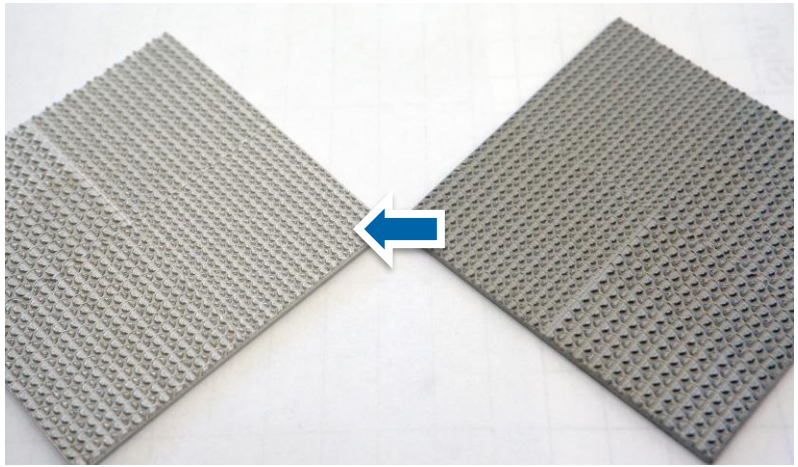
> Gloss enhancement and roughness decrease

> Reduction of built step visibility

APPLICATION: DESIGN/GLOSS

AM (SLM) part

- Material: steel 316l
- Specific AM-friendly surface design



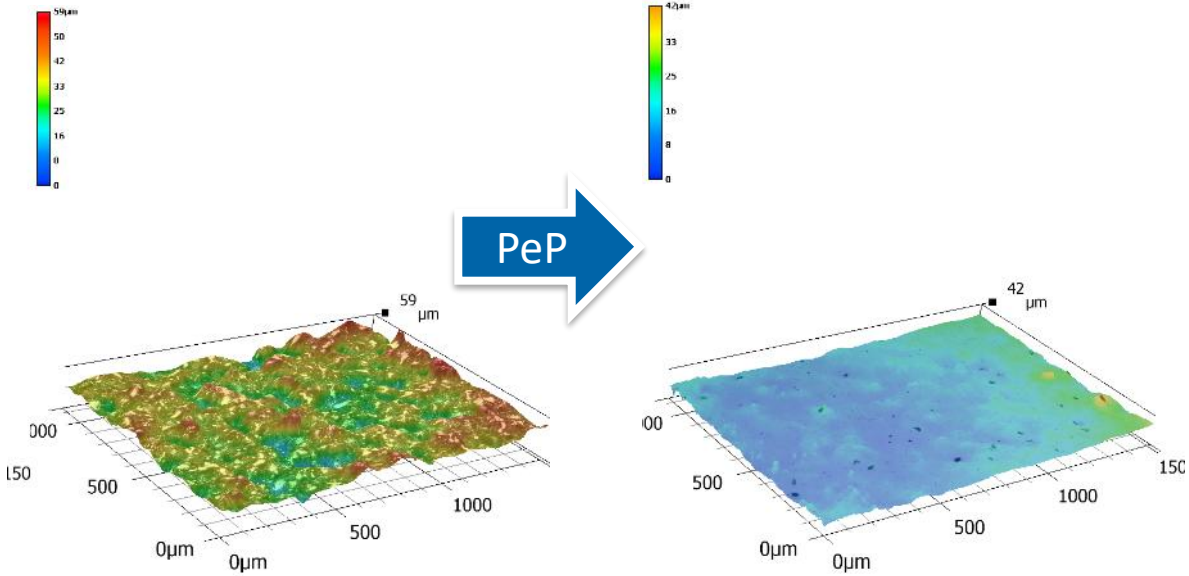
AM SURFACE CHANGE AFTER PeP

AM (SLM) part

- Material: 316L steel
- Polishing time 40min.
- Pre-treatment: nil

> Gloss enhancement and roughness decrease

> Reduction of built step visibility



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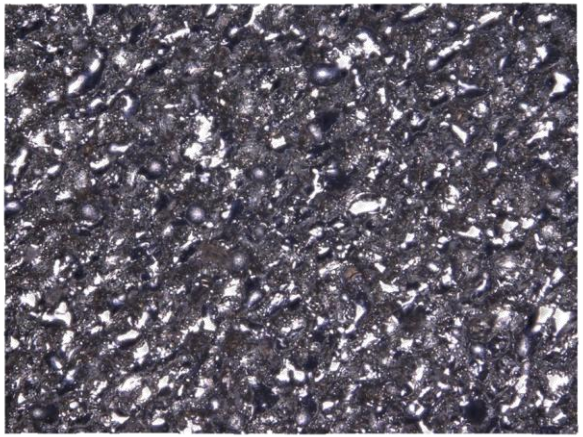
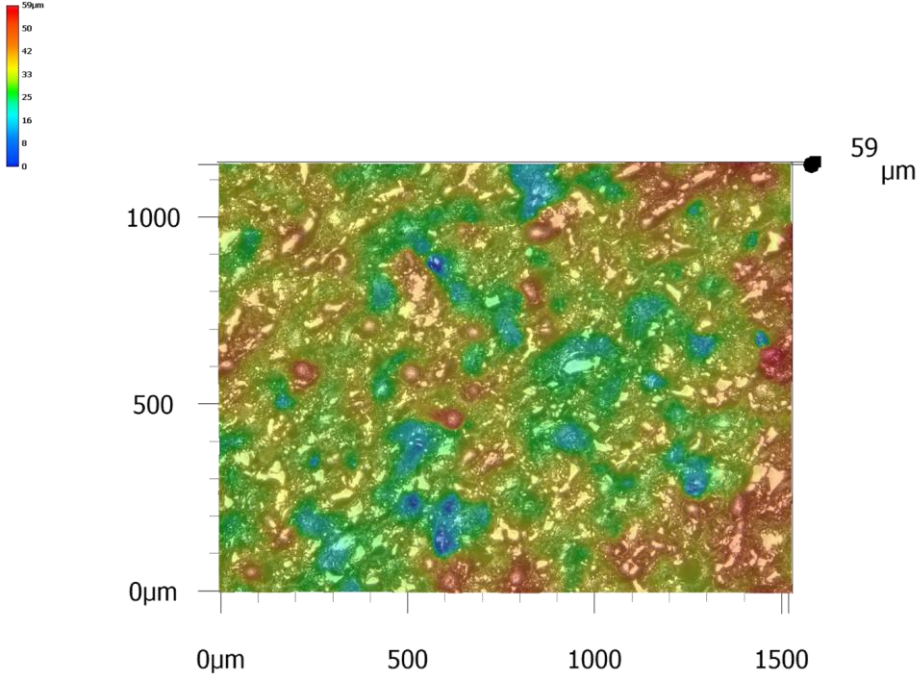
AM PeP



Steel SLM part, 2min. PeP



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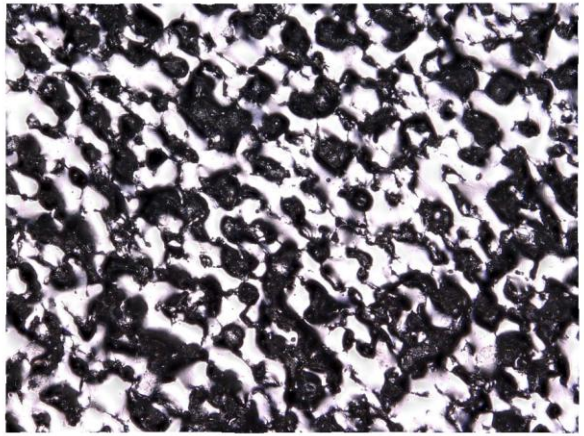
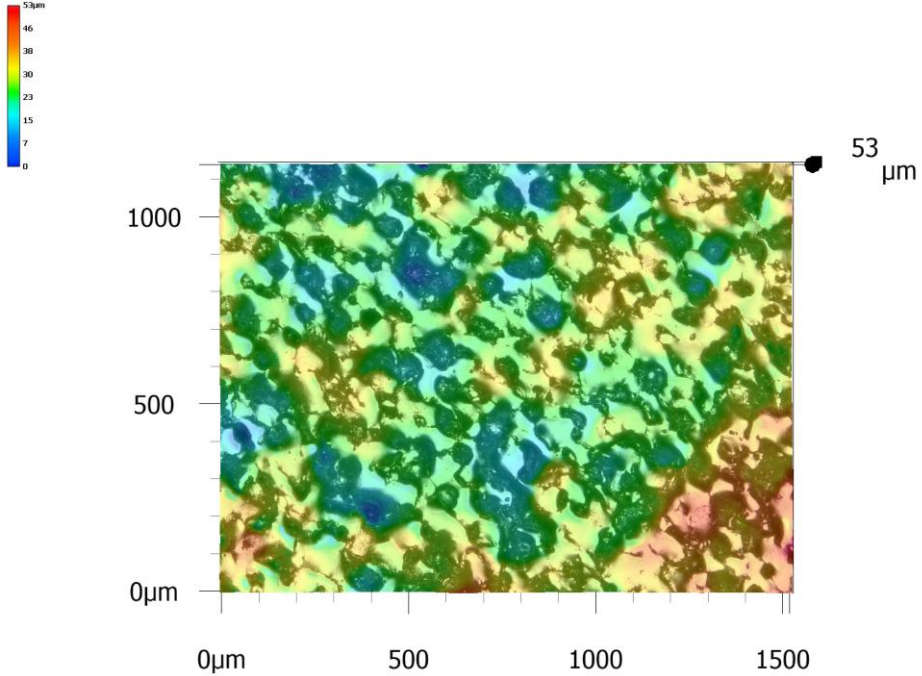
AM PeP



Steel SLM part, 8 min. PeP



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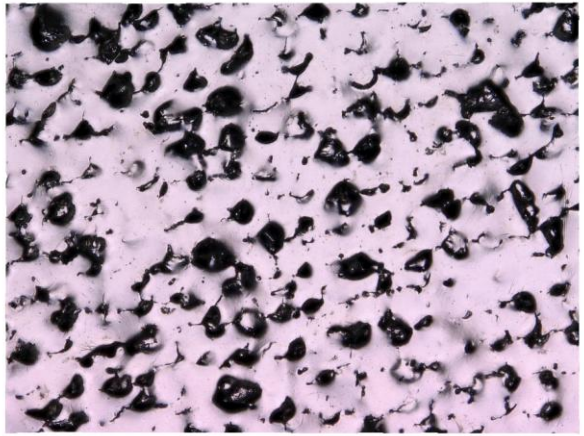
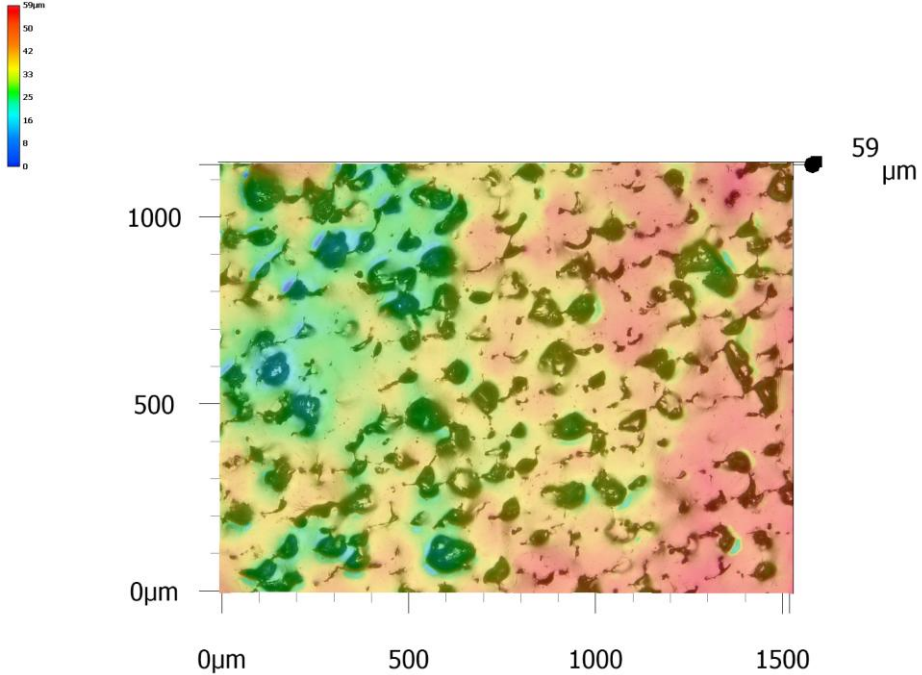
AM PeP



Steel SLM part, 16 min. PeP



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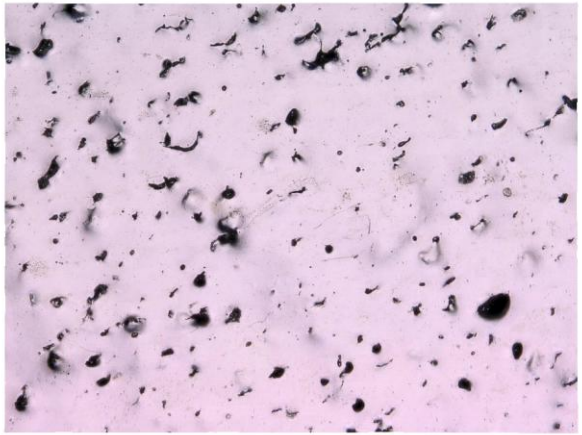
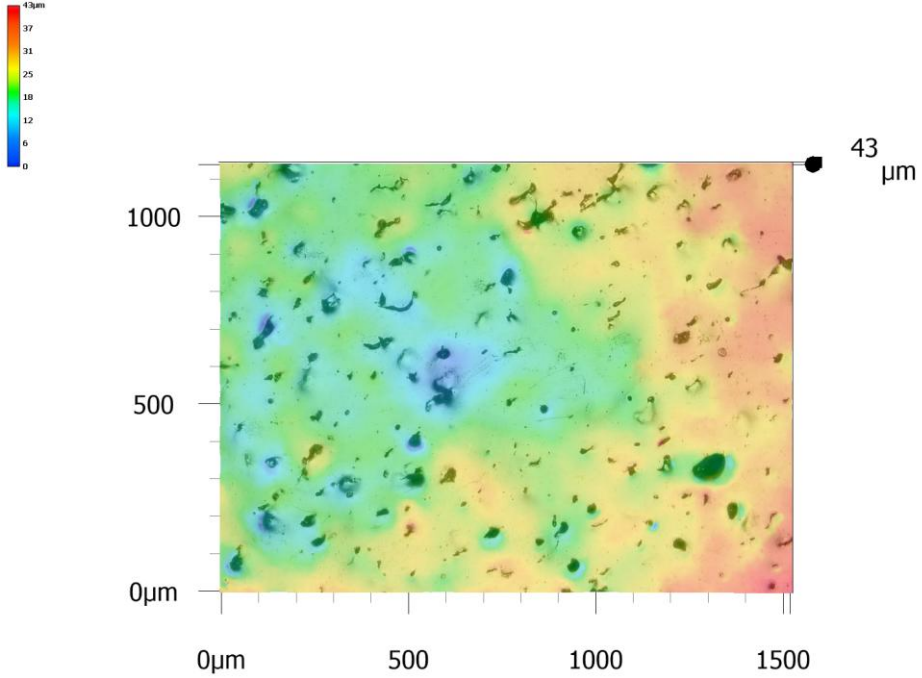
AM PeP



Steel SLM part, 30 min. PeP



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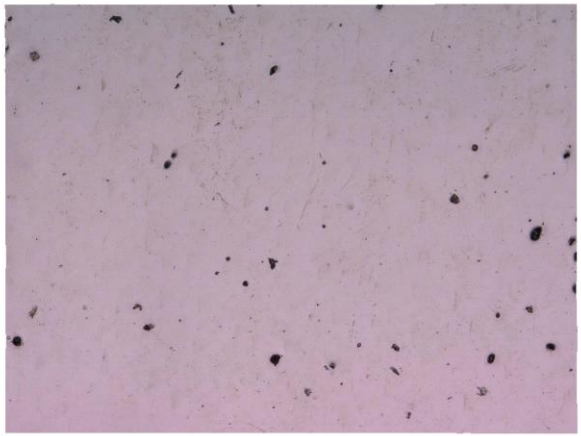
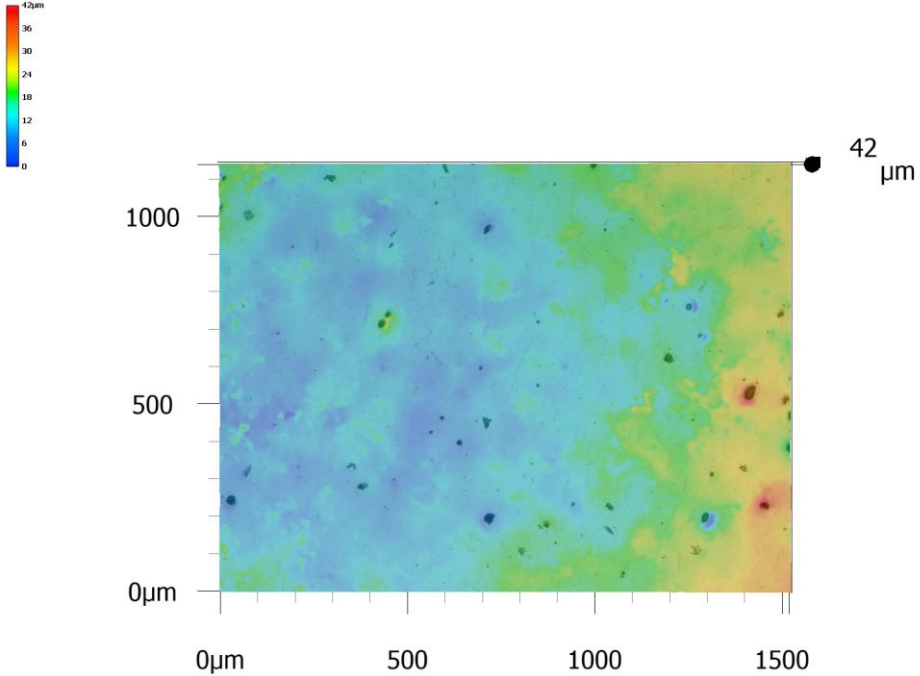
AM PeP



Steel SLM part, 40 min. PeP



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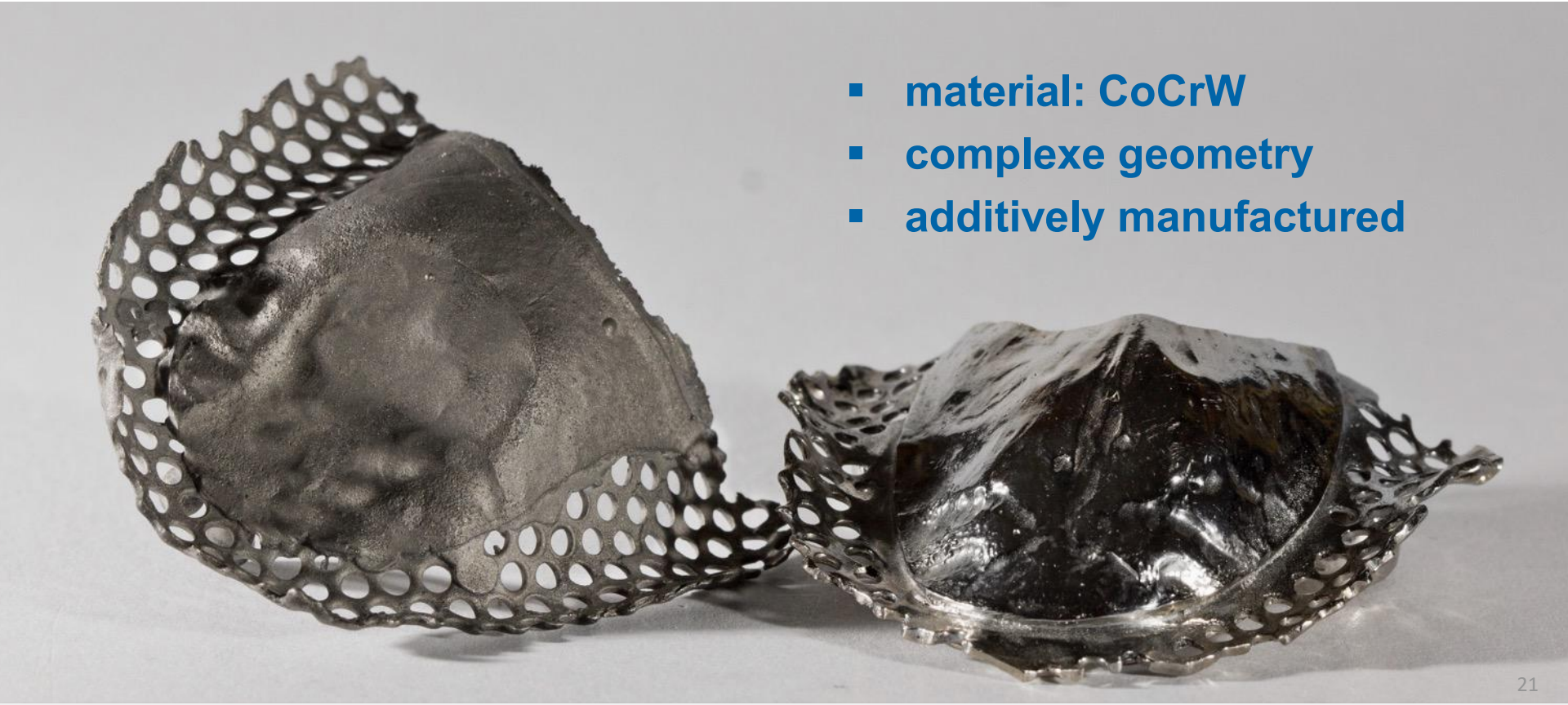
PeP on CoCrMo



- material: CoCrW
- complexe geometry
- additively manufactured

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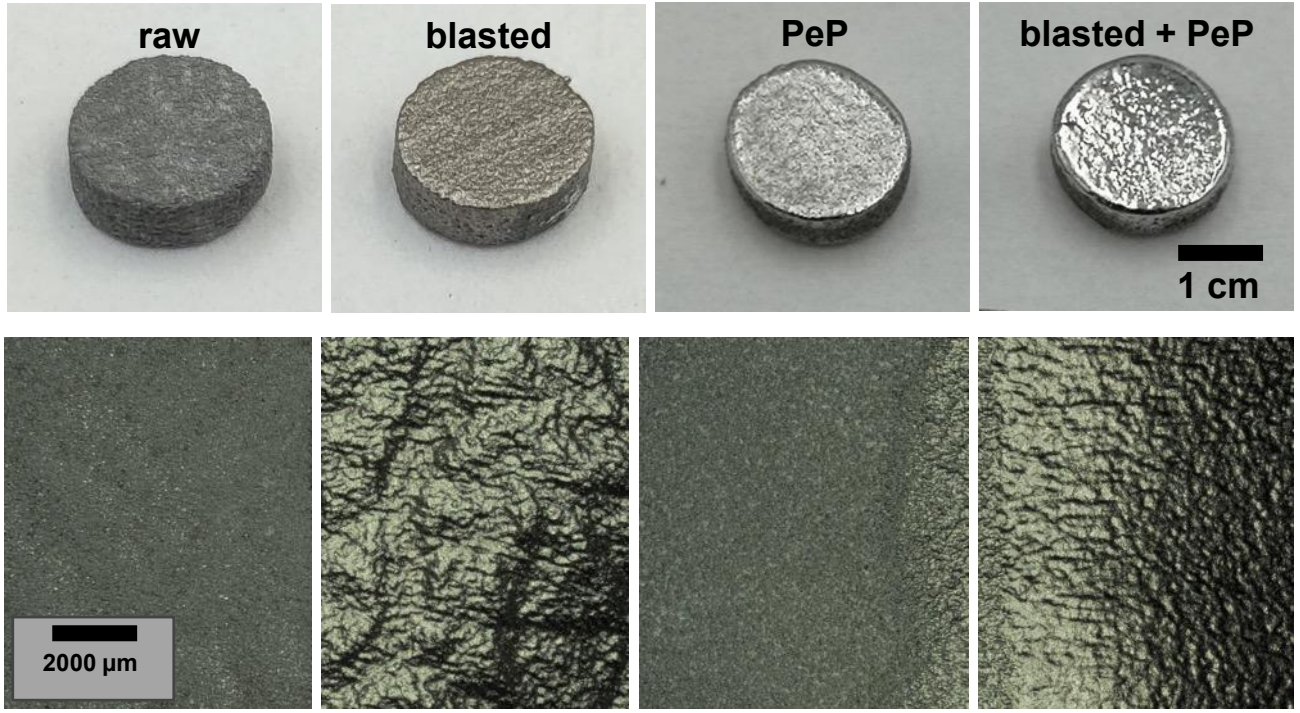
AM-CoCrW



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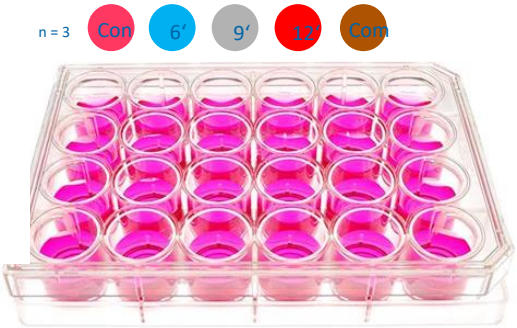
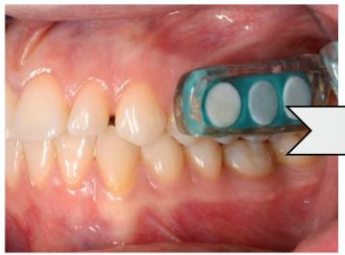
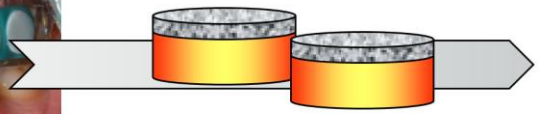
AM-CoCrW

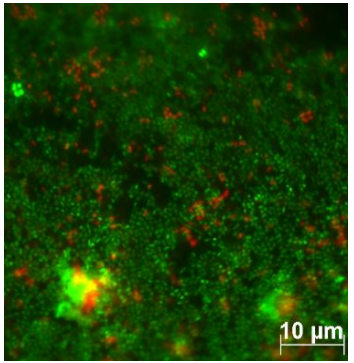
- no cytotoxicity



- bacteria growth in holes







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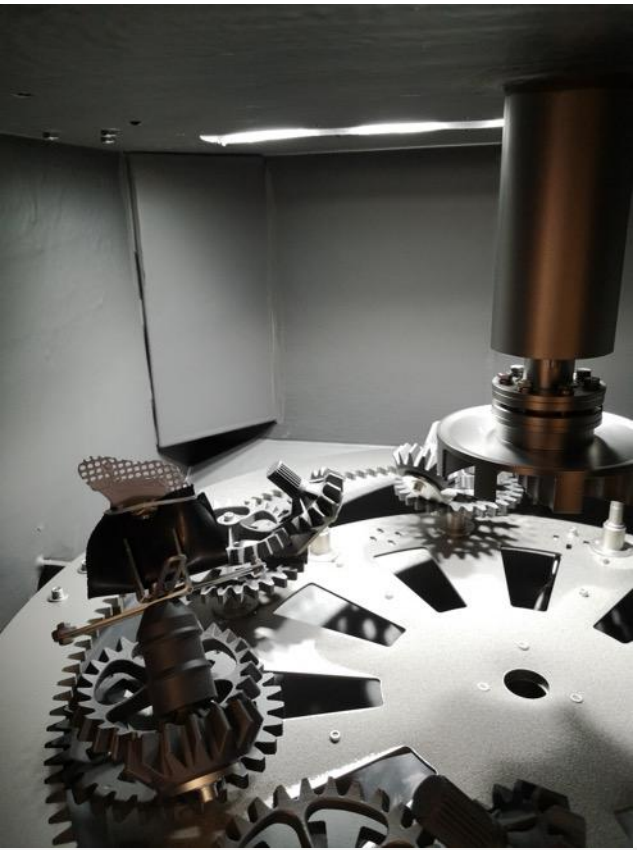
AM-CoCrW – Demo-parts



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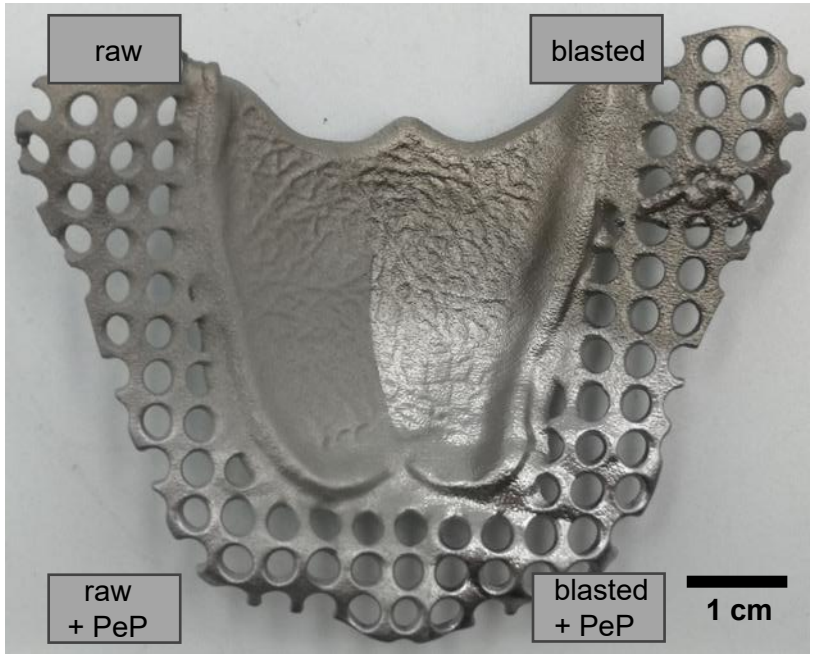
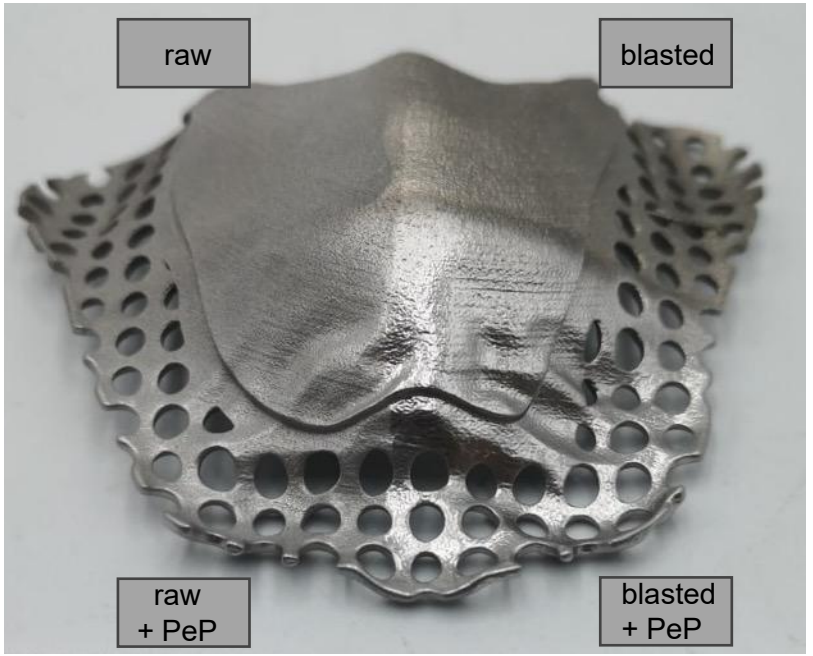
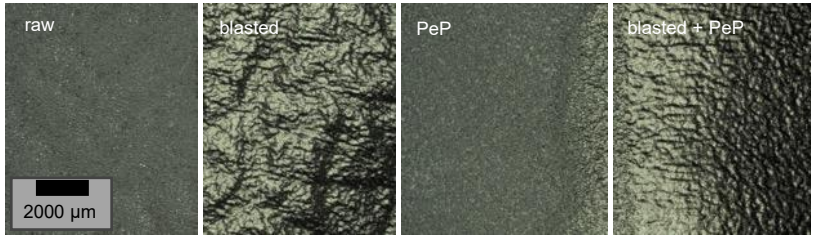
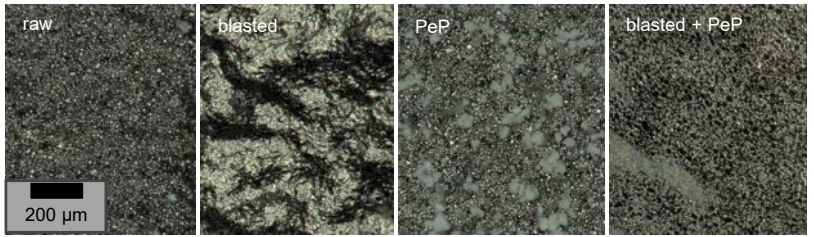
AM-CoCrW – Demo-parts









PeP - device

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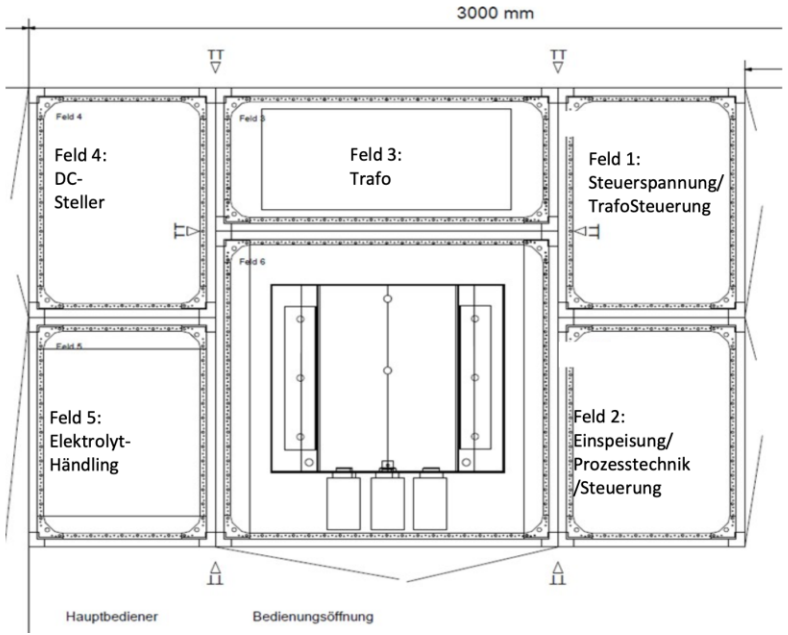
PeP - device



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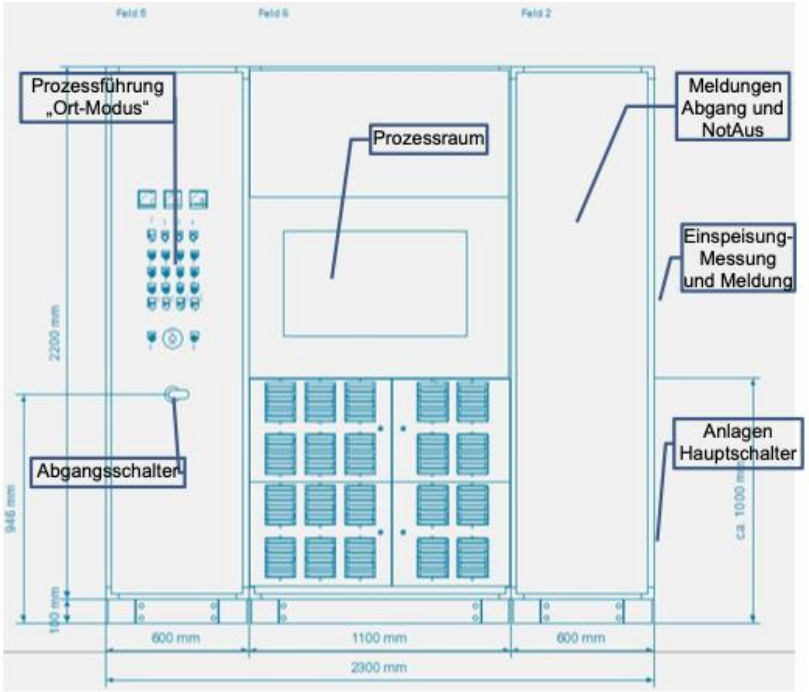
PeP - device



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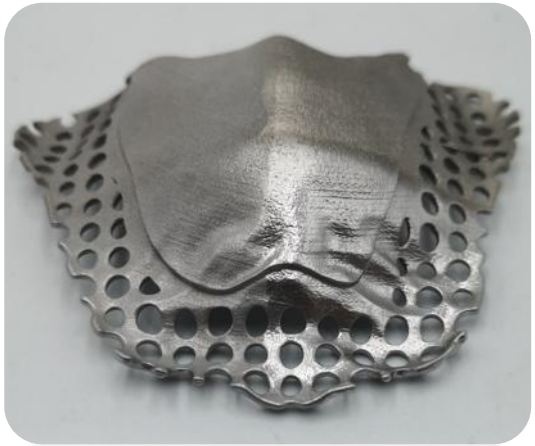
Outlook

- Polishing Modules
- Process Automation
- Dental PeP-Device



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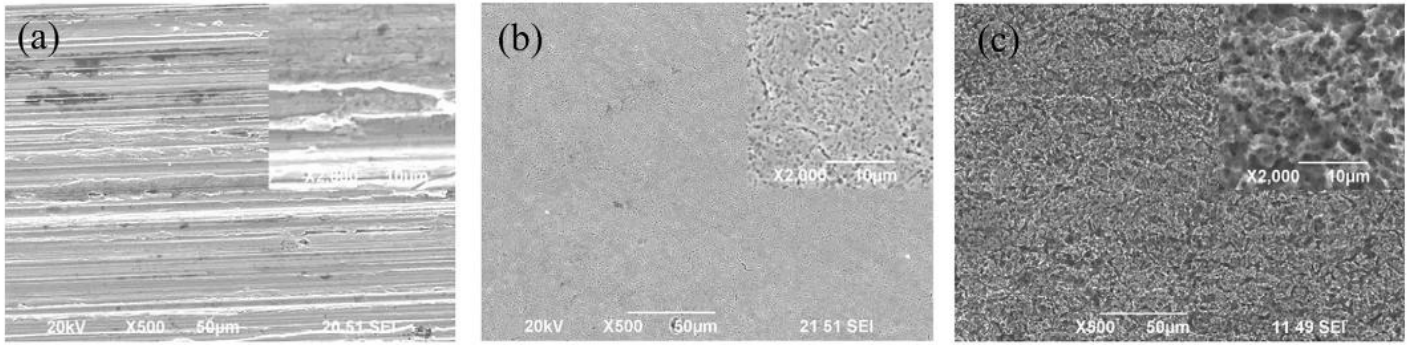


Fig. 4. Surface of stainless steel before treatment (a), after PEP for 15 min at 350 V (b) and after electrochemical polishing at 9 V (c) [55].

Comparison to Electrochemical Machining (ECM) and electrical discharge machining (EDM)

property	EDM	ECM	PeP
Voltage [V]	75–400	< 60	180–370
Elektrode-distance [mm]	0.005–0.5	0.015–1	5–500
Contact	Anode or Cathode	Anode	Anode
electrolyte	no (dielectric)	yes	yes
glossy surface	no	depending on parameter	yes

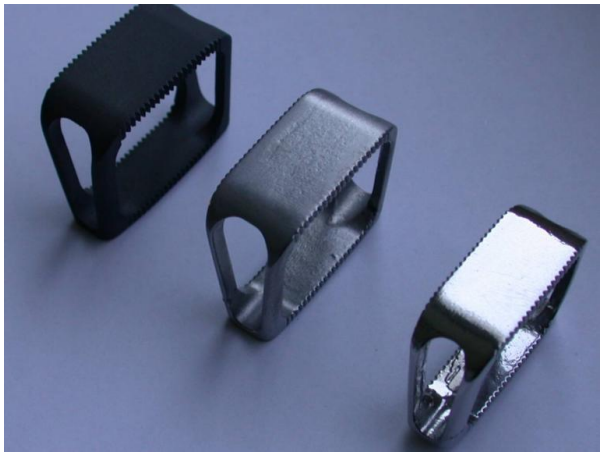
APPLICATION: APPEARANCE

Cast parts

- Material: Ti6Al4V
- Target: smooth surface, gloss and shine increase
- Pre-treatment: corundum blasting

> Gloss enhancement and roughness decrease

> Reduction of cast skin



APPLICATION: CORROSION INHIBITION

Copper medtech part

- Material: copper
- Target: surface corroding less fast
- Pre-treatment: nil

> Decrease in oxidation speed

> Salt spray test supports slower corrosion statement

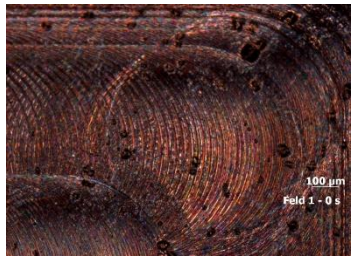
APPLICATION: COATING

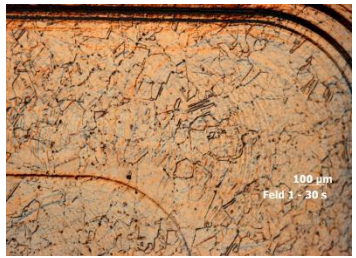
Micro-milled part

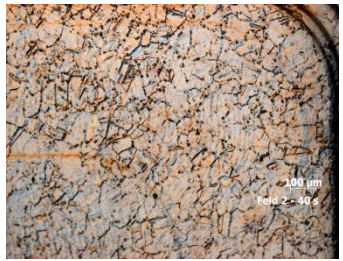
- Material: copper
- Target: deburring, surface smoothing
- Pre-treatment: nil

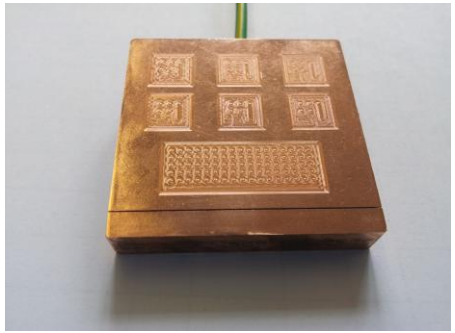
> Smoothing and grain boundary ‚etching‘

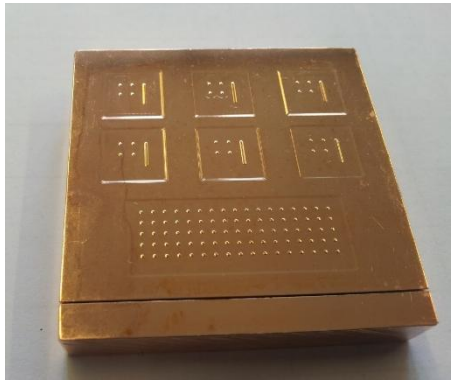
> Small window of suitability before roughness increase









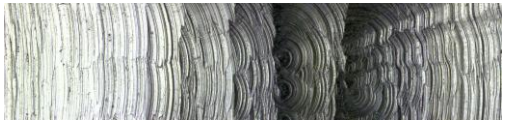


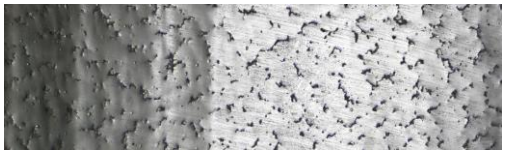
APPLICATION: MEDICAL

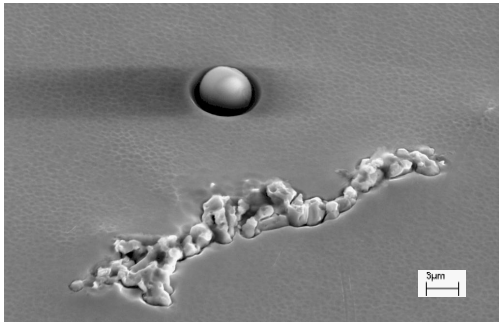
Implant part

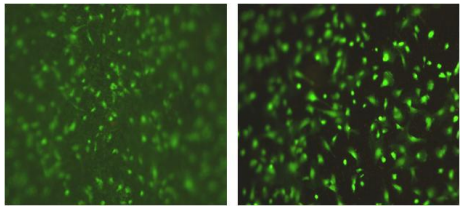
- Material: CoCr
- Target: deburring, surface smoothing, biocompatible
- Pre-treatment: fine machining / cutting

> Smoothing depending on *real* material composition
> No cytotoxicity based on process
> Bacteria growth inhibited









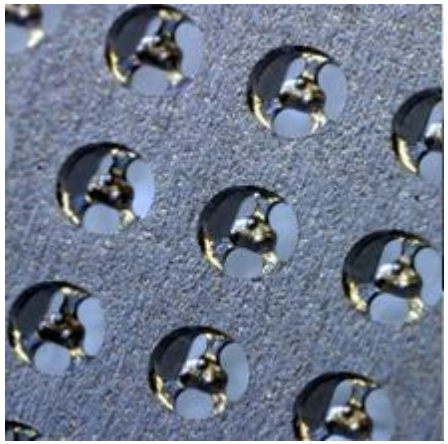
APPLICATION: MEDICAL

Medical tools and implant parts

- Material: CoCr (bottom) or stainless steel (top)
- Target: deburring, surface smoothing, biocompatible
- Pre-treatment: fine machining / cutting

> Smoothing depending on *real* material composition
> High gloss
> Sterile after PeP

APPLICATION: MICRO PARTS



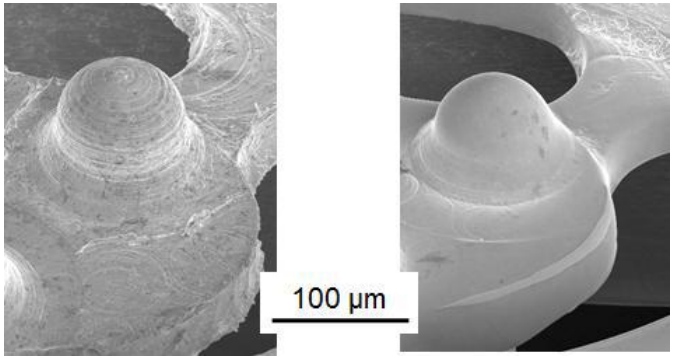
Cast parts

- Material: Ti6Al4V
- Target: smooth surface, remove burrs and keep accuracy
- Pre-treatment: nil

> Removal of burr from milling

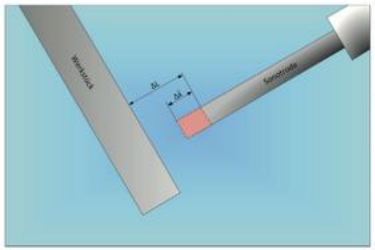
> Roughness decrease

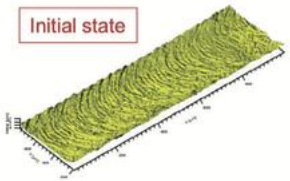
> No feature deviation



Alleinstellungsmerkmal PePtopus

ULTRASCHALLPOLIEREN
www.ultraschallpolieren.de





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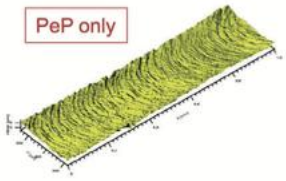

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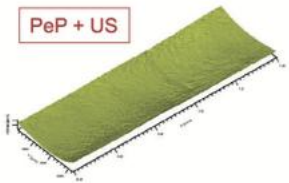
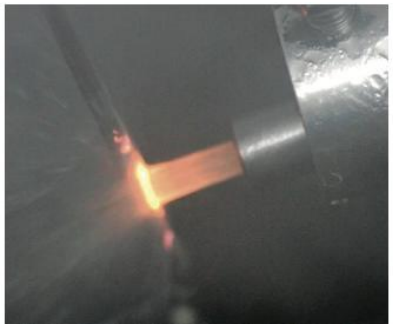
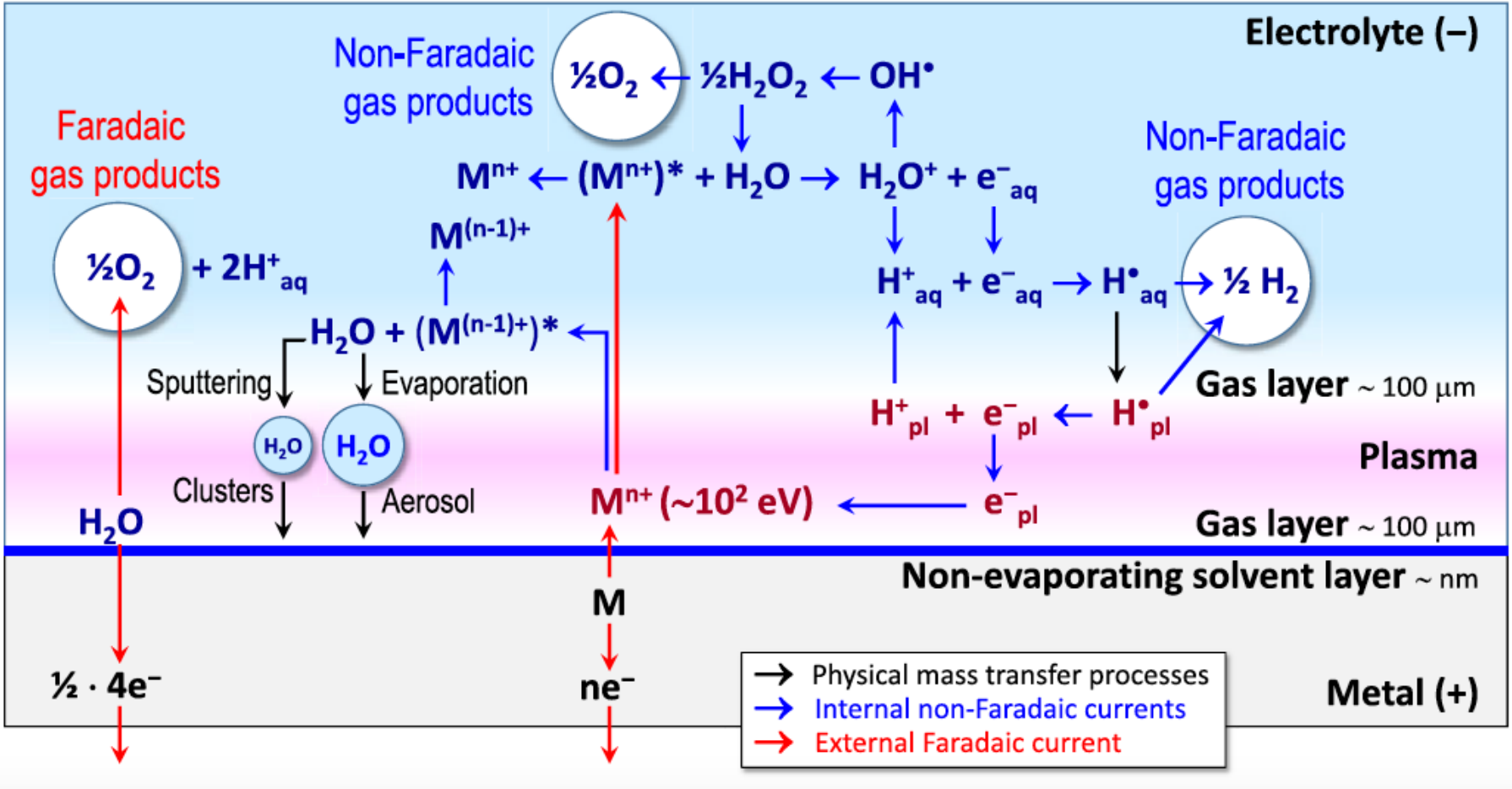


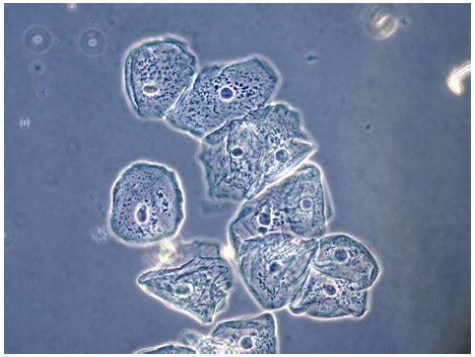
S_a = 0,24 Qm

STRAHLPOLIEREN

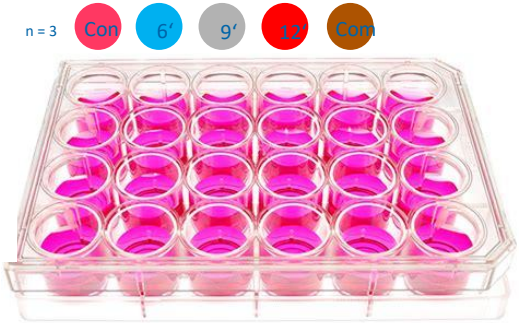



Electrolyte (–)
Non-Faradaic gas products
½O2
½H2O2
OH•
Faradaic gas products
Non-Faradaic gas products
Mn+
(Mn+)* + H2O
H2O+ + e−aq
M(n-1)+
½ O2
+ 2H+aq
H+aq + e−aq
H•aq
½ H2
H2O + (M(n-1)+)*
Sputtering
Evaporation
Gas layer ~ 100 µm
H+pl + e−pl
H•pl
Plasma
H2O
H2O
Clusters
Aerosol
Mn+ (~10² eV)
e−pl
Gas layer ~ 100 µm
H2O
Non-evaporating solvent layer ~ nm
M
½ · 4e−
ne−
Physical mass transfer processes
Internal non-Faradaic currents
External Faradaic current
Metal (+)

Proliferation-Assay (MTS, LDH, DNA-Assay)



- Zellkulturversuche zur Zytotoxizität nach ISO-Norm an oral epithelial cells (oEC)
- Kontrollen: konventionell gefräste Chrom-Kobalt-Molybdän-Legierung, Polystyrol, Füllungskomposit mit Sauerstoffinhibitionsschicht



Arbeitsinhalte und Methodisches Vorgehen

- Probenträgerherstellung, Probeninsertion
- Biofilmgenerierung in der Mundhöhle
- Fluoreszenzmikroskopische Untersuchung
- Zytotoxizitätsuntersuchungen im Zellkulturmodell