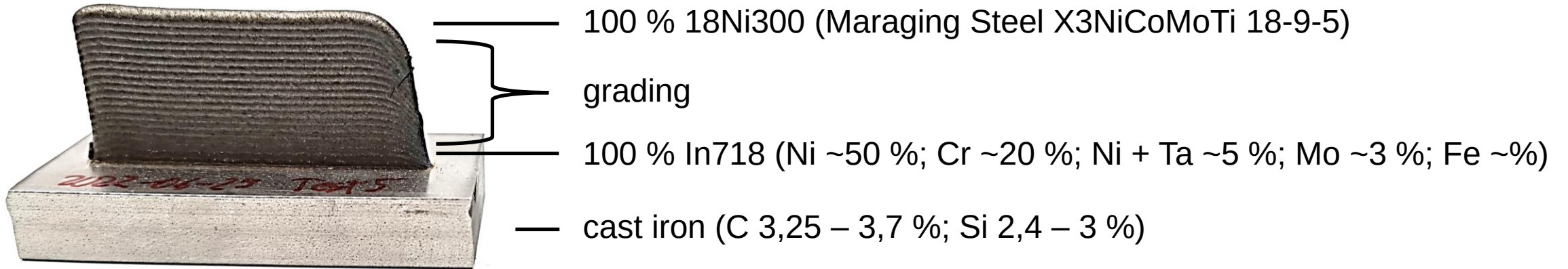


MULTI-MATERIAL PARTS IN PEP

Challenges and Options

Multi-material parts in PeP: challenges and options

e.g.: functional graded material (FGM)



	18Ni300	In718+	cast iron
$(\text{NH}_4)_2\text{SO}_4 + \text{H}_2\text{SO}_4$	+	- (dark oxid layers)	- (Fe-oxid, graphite)
$(\text{NH}_4)_2\text{SO}_4 + \text{C}_6\text{H}_8\text{O}_7$	+	+ (gelblicher Schimmer)	- (graphite)
Na_2CO_3	+ (but low removal)	+ (but low removal)	+ (but low removal)

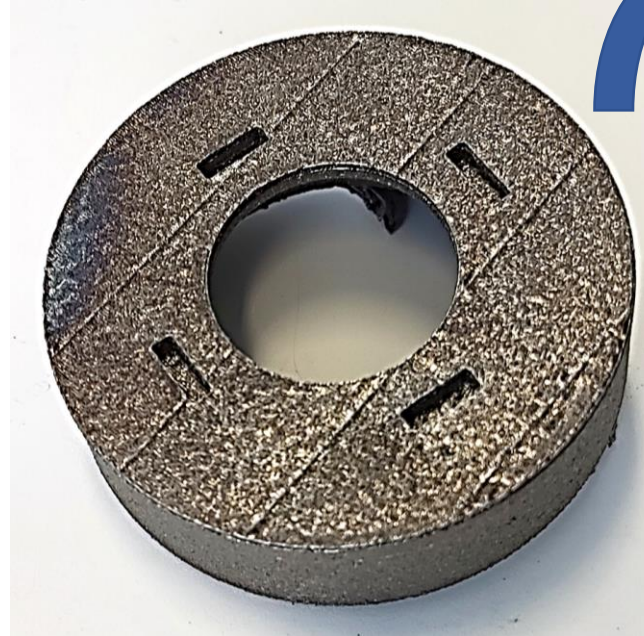
- non stainless steels @ high acidic solutions (e.g. ammonium) → rust --> option: use of milder citric acid
- grafit can fall out of maxtrix or burned due to glow discharges
- in general: in multicomponent systems different removal rates of single components may cause problems

Multi-material parts in PeP: challenges and options

Results on single materials: In718 and 18Ni300 @ $(\text{NH}_4)_2\text{SO}_4 + \text{C}_6\text{H}_8\text{O}_7$



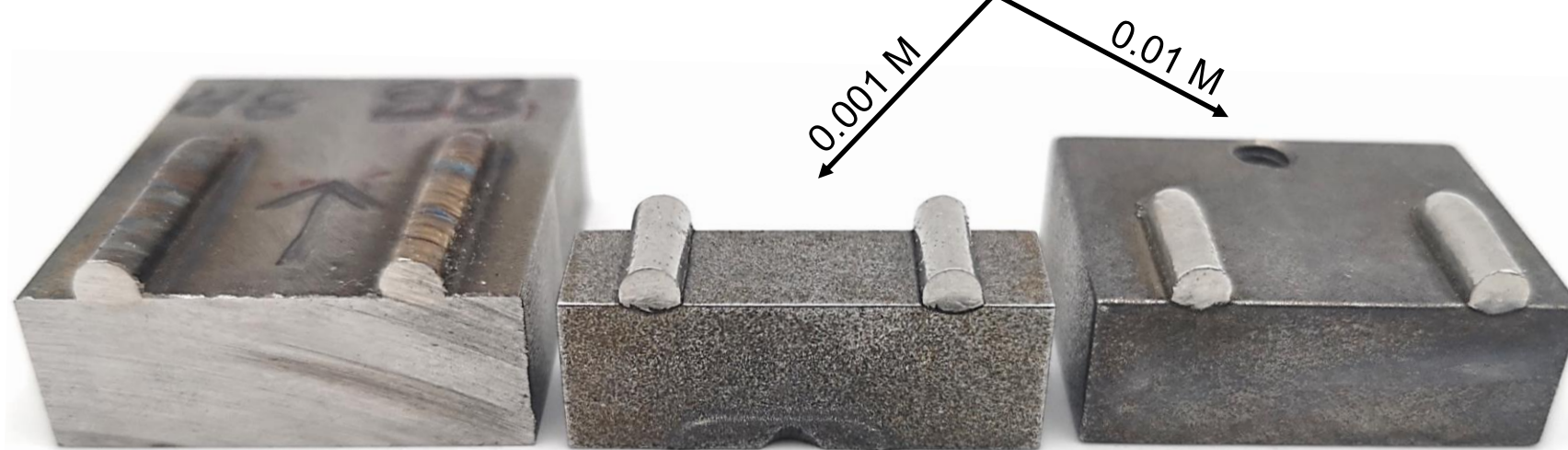
surface smoothing + gloss increase



surface smoothing + gloss increase
some brownish/black shadows in
regions of unfavourable electrolyt
Flow (e.g. part clamping)

Multi-material parts in PeP: challenges and options

Results on FGM-like sample @ $(\text{NH}_4)_2\text{SO}_4 + \text{C}_6\text{H}_8\text{O}_7$



top layers: 18Ni300

Interlayer: In718

base: cast iron



18Ni300 → bright and high gloss

Cast iron → yellow/brownish/black dots

→ dark, matte, no gloss

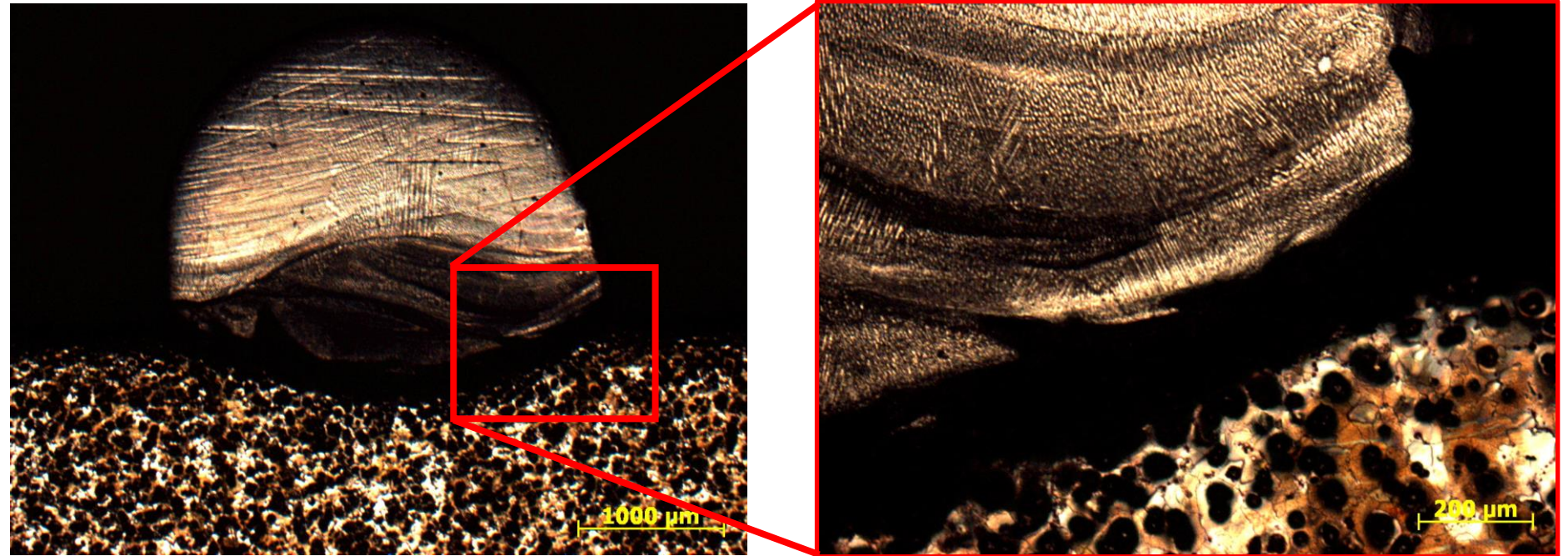
Multi-material parts in PeP: challenges and options

Results on FGM-like sample @ $(\text{NH}_4)_2\text{SO}_4 + \text{C}_6\text{H}_8\text{O}_7$

top layers: 18Ni300

Interlayer: In718

base: cast iron

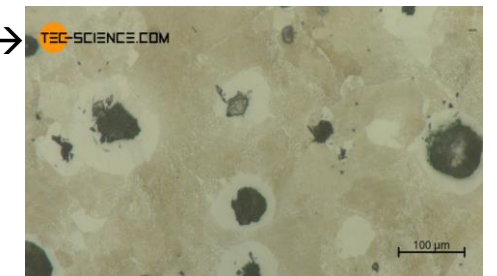


18Ni300 → bright and high gloss

In718 → seam to be removed very strong

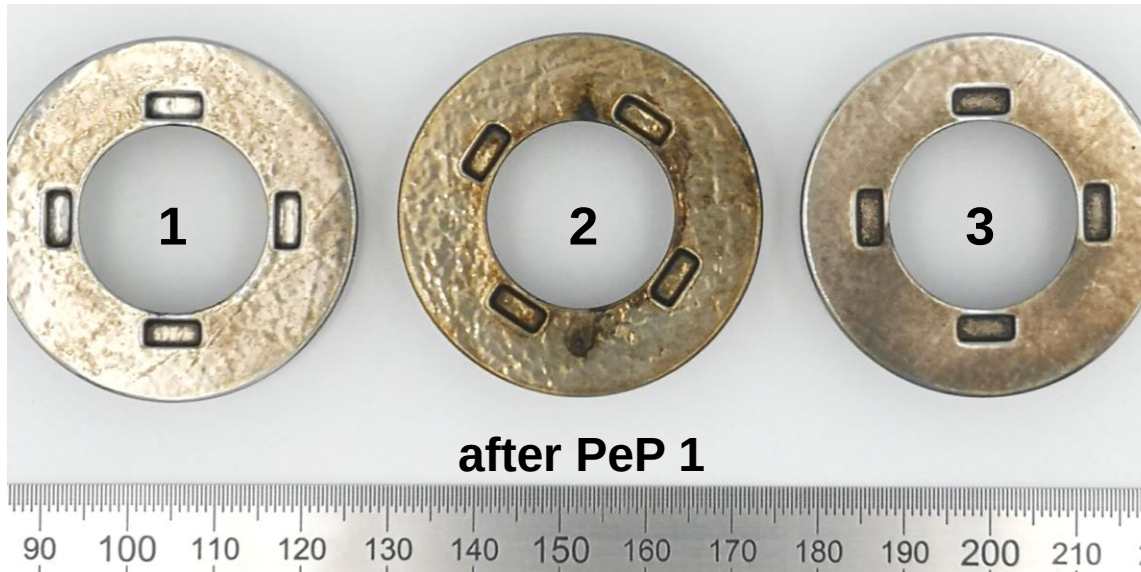
Cast iron → lot of large holes (erosion and leaching of globular graphite creates new surfaces where process can attach)

untreated spheroidal graphit iron (3.6 % C, dark) →



Multi-material parts in PeP: challenges and options

Results on AM 18Ni300 @ different electrolyte solutions



Part- #	Electrolyte solution	κ / Sm^{-1} @ 75 °C	pH	U / V	t / min	T / °C	I / A	Mass reduc- tion / %
1	0.33 M $(\text{NH}_4)_2\text{SO}_4$ + 0.01 M $\text{C}_6\text{H}_8\text{O}_7$	11.3	4	318 (314)	8 x 5	75...89	18...11	10.1
2	0.33 M $(\text{NH}_4)_2\text{SO}_4$ + 0.01 M $\text{C}_6\text{H}_8\text{O}_7$	11.3	4	342 (339)	8 x 5	75...88	17...11	10.7
3	0.33 M $(\text{NH}_4)_2\text{SO}_4$ + H_2SO_4	10.1	2	321 (317)	8 x 5	75...89	20...11	9.7
each	0.5 M Na_2CO_3	12.5	-		8 x 5	75...90	21...12	> 0.1