POROSITY ANALYSIS OF 3D PRINTED PRODUCTS

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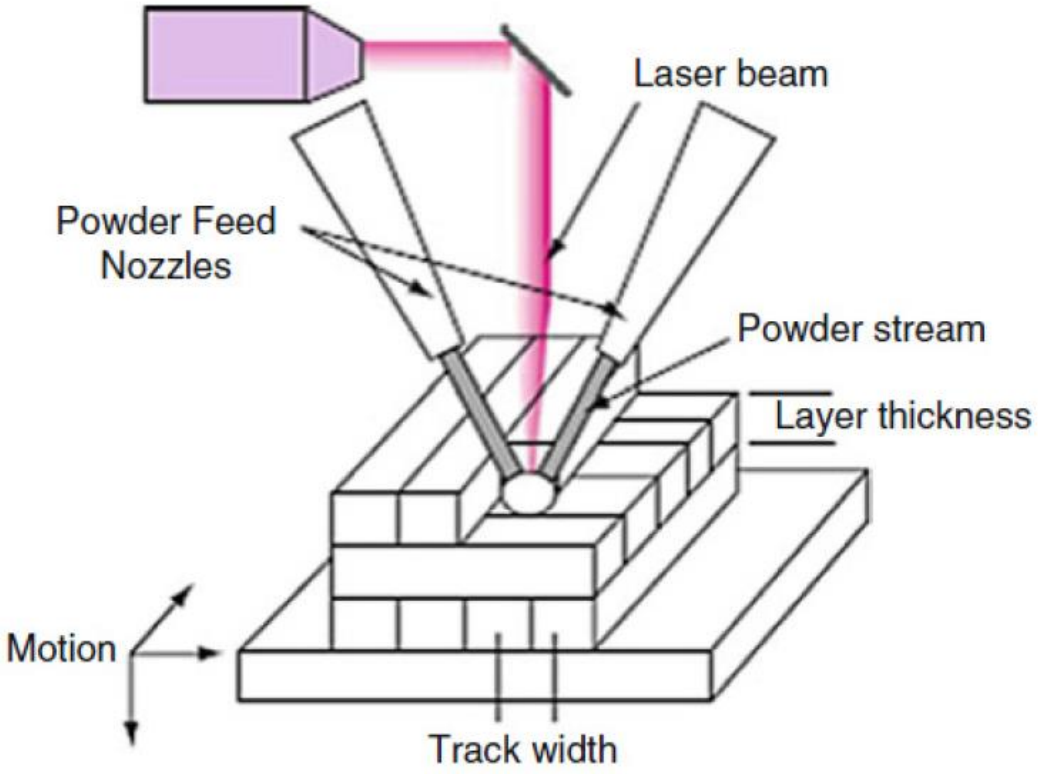
STRUCTURE OF PRESENTATION

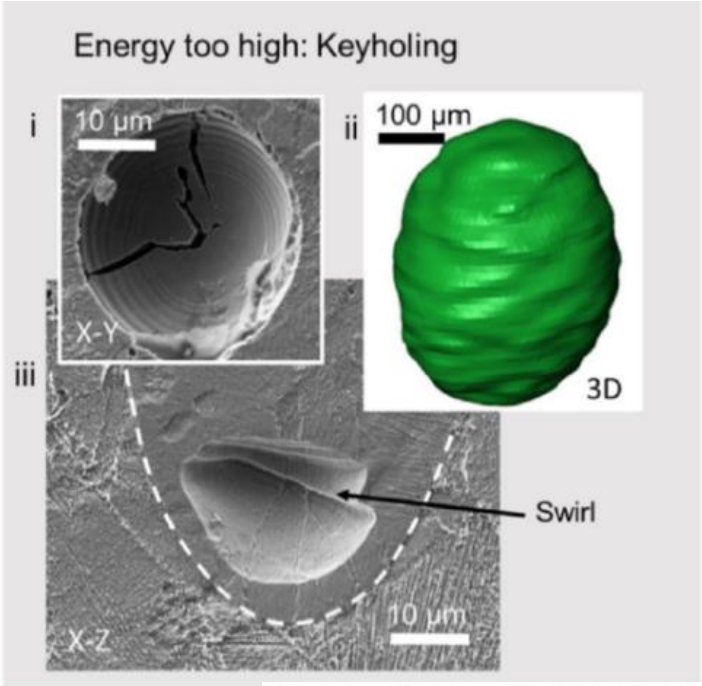
- Additive manufacturing (method DED)
- Porosity
- Types of pores
- Methods for determination
- Results
- Conclusion
- Bibliography
- Discussion

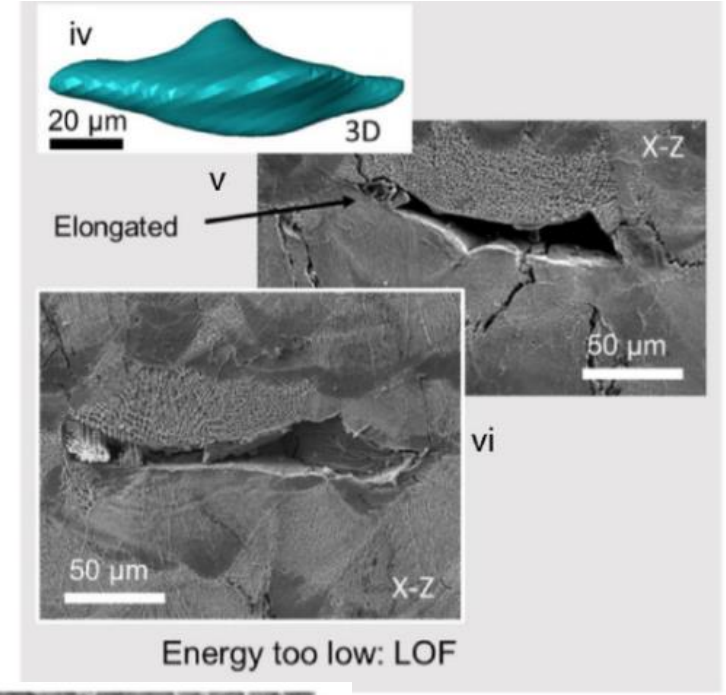
ADDITIVE MANUFACTURING – METHOD DED

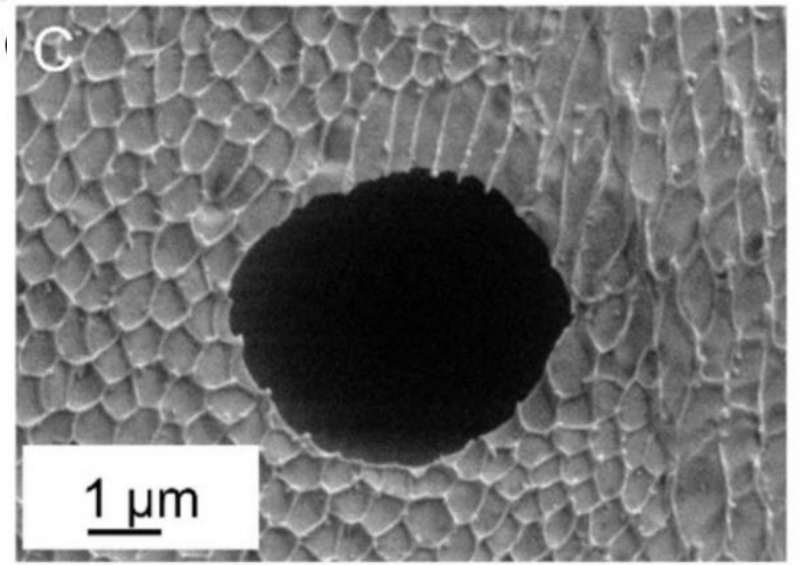


POROSITY

- Types of pores
  - Keyhole, Lack of Fusion, Gas pores
- **(types, distribution and frequency)**
- Impact on product´s mechanical properties







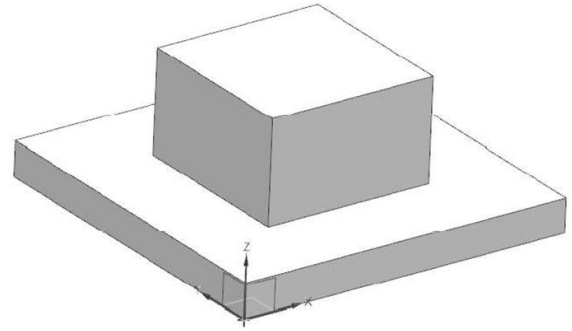
METHODS FOR DETECTION

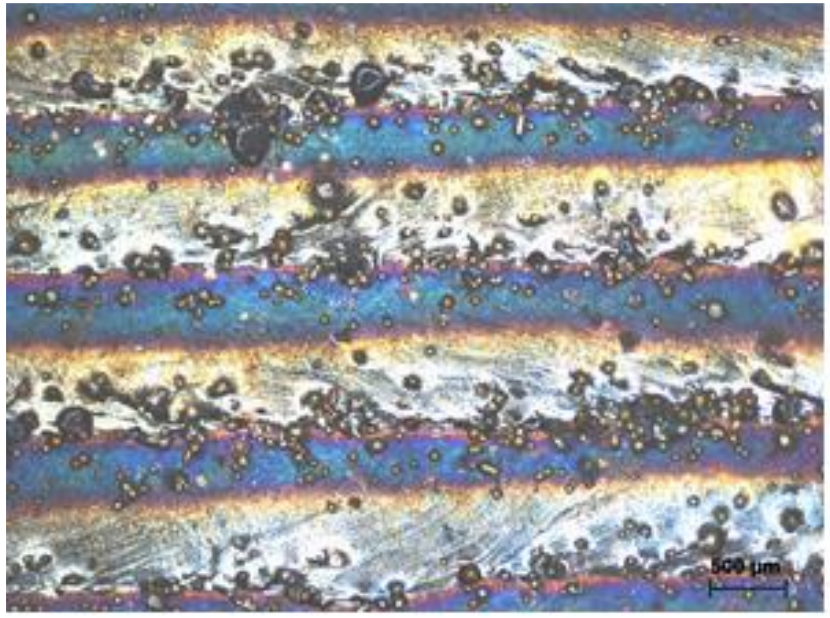
- Non-destructive
  - RTG
  - US (ultrasound)
  - He pycnometry
- Destructive
  - Microscopy

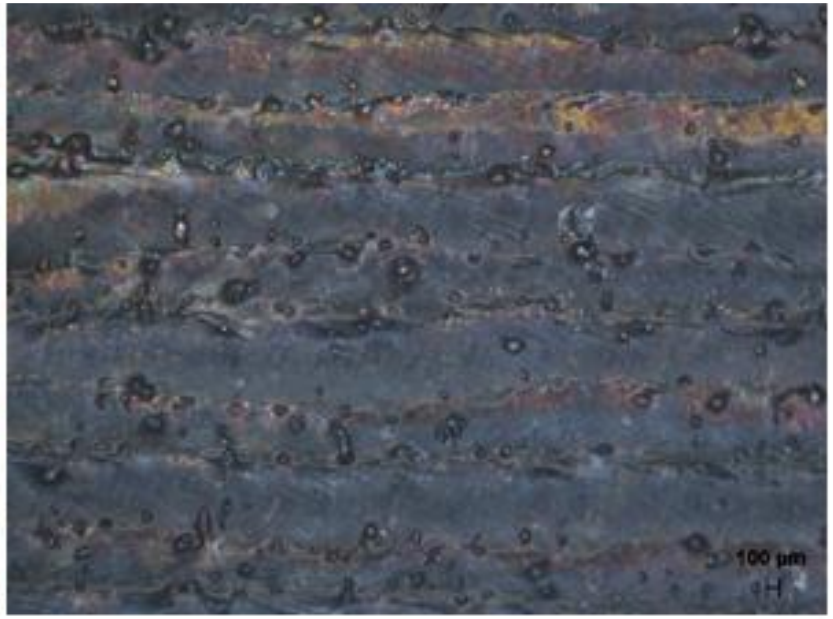
SAMPLES

- 3 samples (COMTES FHT a.s. in Dobřany)
- Made of 316 L
- Method DED, tactics ZigZag
- Indentical parameters; Power: 1 kW

- InssTek MX-600
- Printing module: SDM1600
- Amount of powder: 5.6 g/min
- Time of process: 50 min



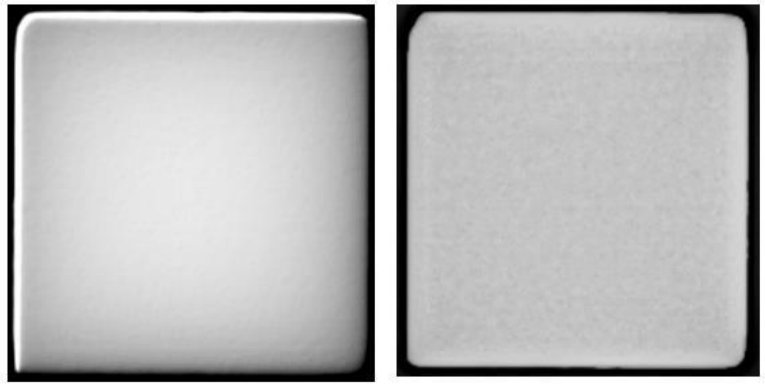




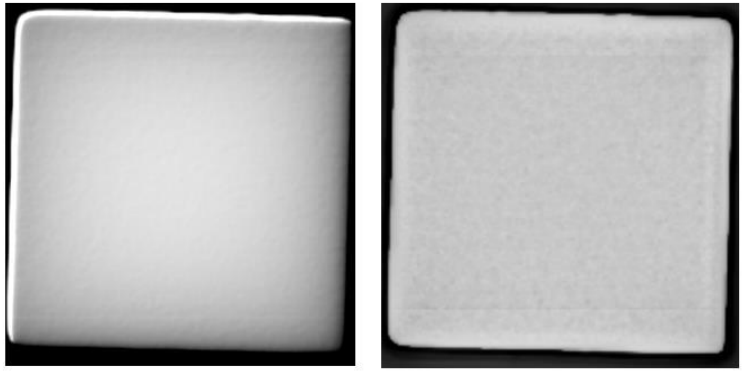
NON-DESTRUCTIVE METHODS

X-RAY TESTING

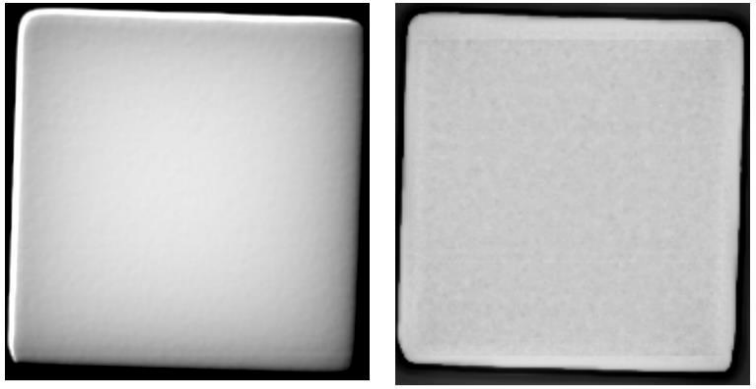
- Distinguish ability: 0.250 mm



Sample A



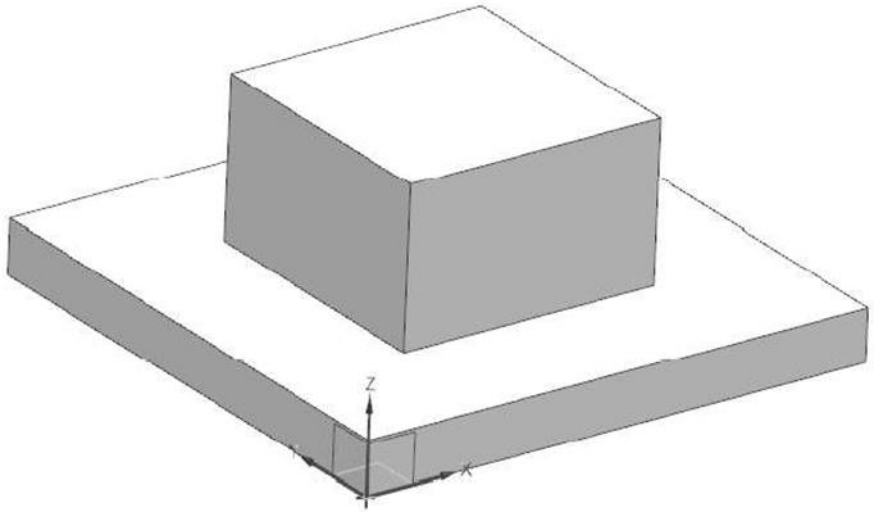
Sample B



Sample C

ULTRASOUND

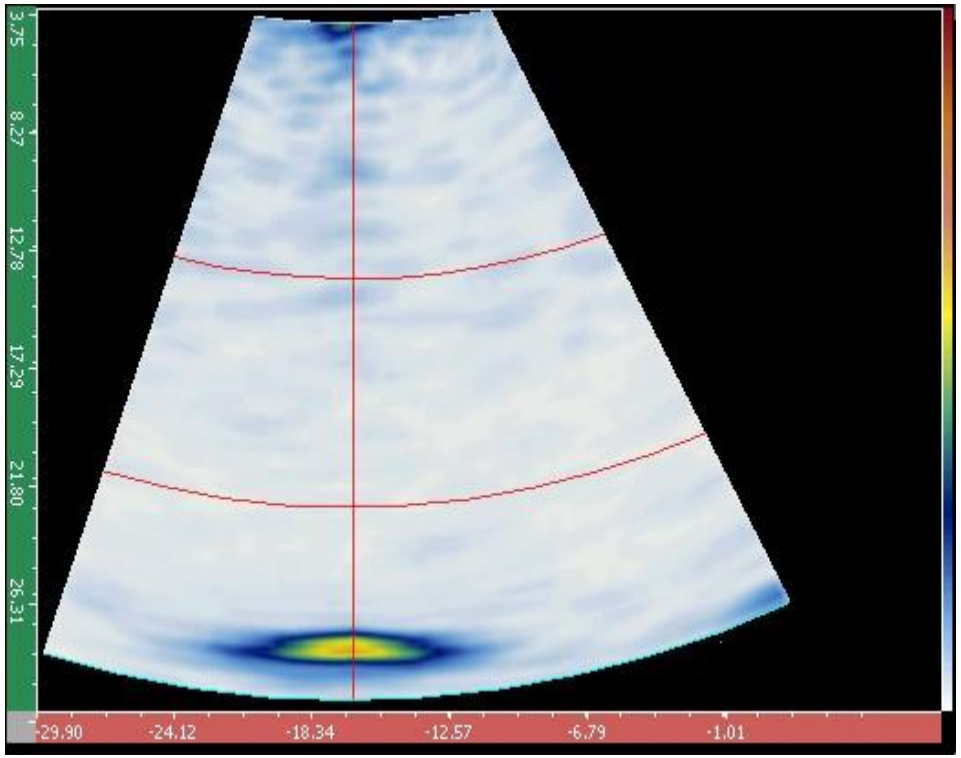
- Methods: Pulse-Echo, Phased Array



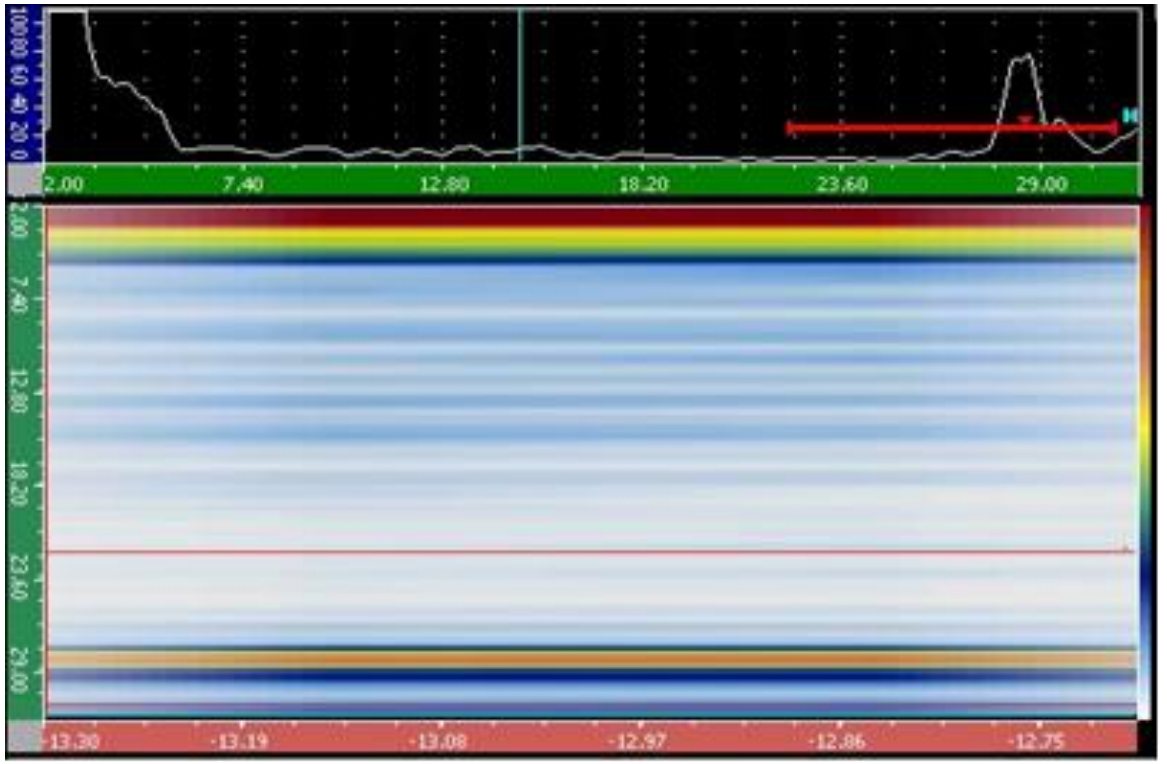
Sample		Used probe			
		CN4-10	CN10-5	V156-5	V153
direction y	A	X	X	X	X
	B	X	X	X	X
	C	X	X	X	X
direction z	A	X	X	X	X
	B	X	X	X	X
	C	X	X	X	X

ULTRASOUND

- Methods: Pulse-Echo, Phased Array

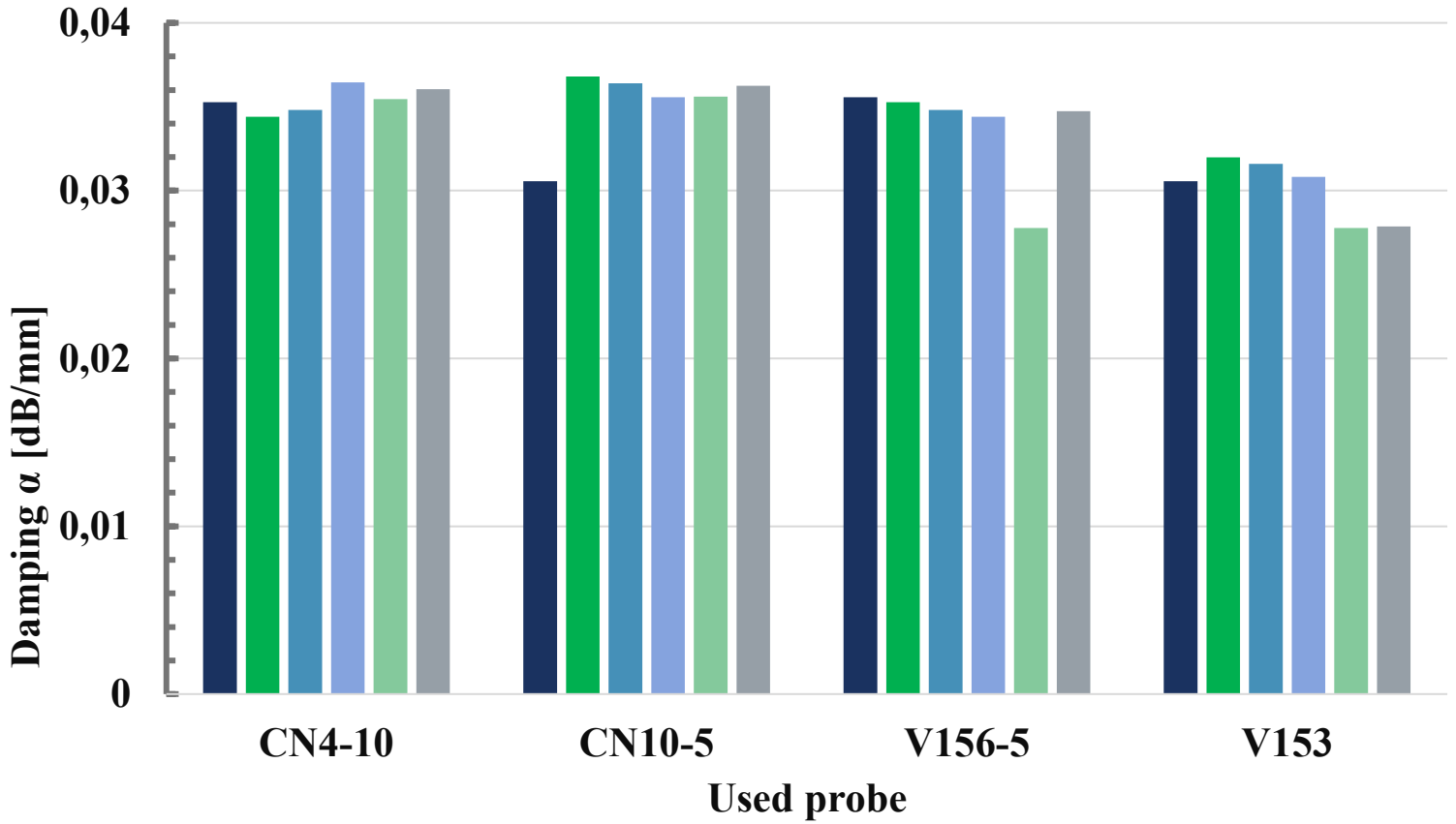


Sector scan of sample A in the direction of building layers



Linear and A- scan of sample A in the direction of building layers

ULTRASOUND



Sample A – in the direction of layer deposition
Sample B – in the direction of layer deposition
Sample C – in the direction of layer deposition
Sample A - direction perpendicular to the direction of layer application
Sample B - direction perpendicular to the direction of layer application
Sample C - direction perpendicular to the direction of layer application

He pycnometry

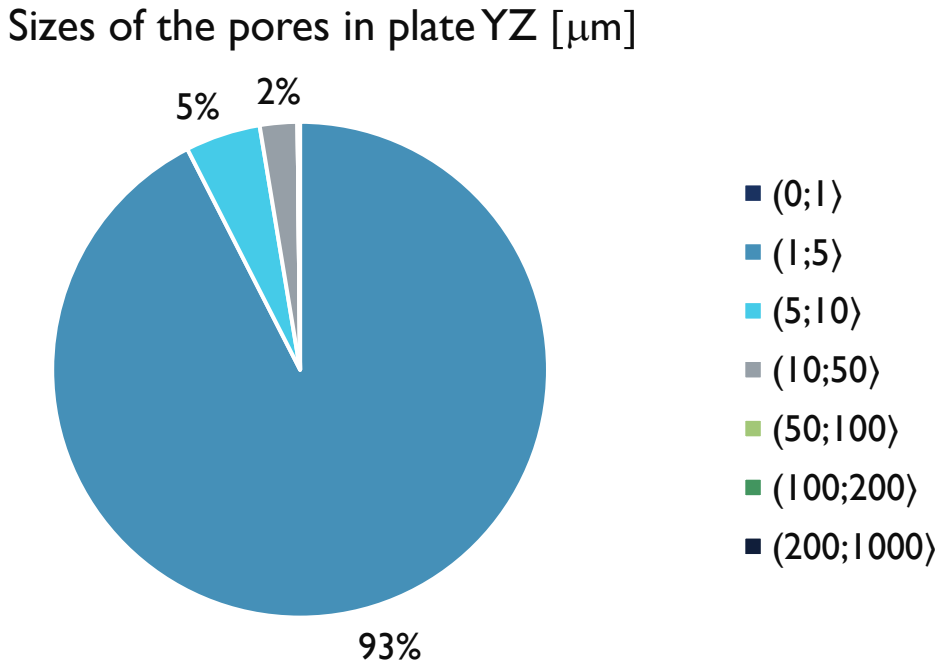
A: 7 914.56 kg/m³

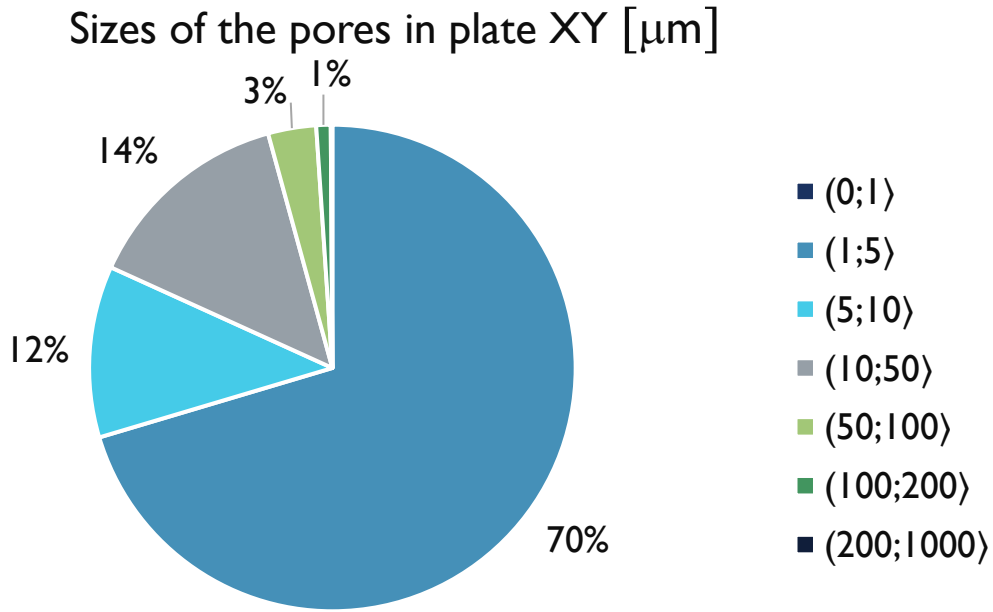
B: 7 916.04 kg/m³

C: 7 922.94 kg/m³

DESTRUCTIVE METHODS

MICROSCOPY


Sizes of the pores in plate YZ [μm]
5%
2%
93%
(0;1⟩
(1;5⟩
(5;10⟩
(10;50⟩
(50;100⟩
(100;200⟩
(200;1000⟩


Sizes of the pores in plate XY [μm]
3%
1%
14%
12%
70%
(0;1⟩
(1;5⟩
(5;10⟩
(10;50⟩
(50;100⟩
(100;200⟩
(200;1000⟩

CONCLUSION

CONCLUSION

- NDT did not detect porosity
- Microscopy **(types, distribution and frequency)**
- All samples: low values of porosity
- Correct choice of methods is necessary
- Combination of the mentioned methods

REFERENCES

- GIBSON, Ian a kol. *Additive Manufacturing Technologies*, ISBN 978-1-4939-2113-3
- WANG, Shuhai a kol. *Role of porosity defects in metal 3D printing: Formation mechanisms, impacts on properties and mitigation strategies*, ISSN 1369-7021
- SNELL, Robert a kol. *Methods for Rapid Pore Classification in Metal Additive Manufacturing*
- DEBROY, T. a kol. *Additive manufacturing of metallic components – Process, structure and properties*

THANK YOU FOR YOUR ATTENTION

Time for your questions