RUHR-UNIVERSITÄT BOCHUM

Experimental investigation and thermographic imaging of geometry-dependent overheating and its effects in PBF-LB/M

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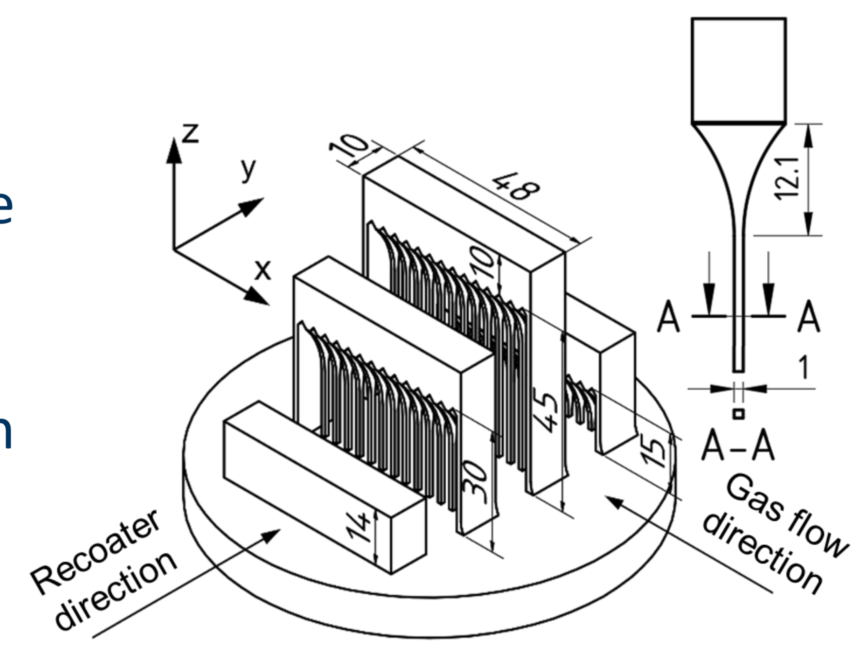
Motivation

- Geometry of the part can induce overheating [1 - 3]
- Overheating can reduce surface quality and geometrical accuracy [4]
- Reduction of Laser power and increasing part temperature can lower induced residual stresses [5, 6]

Materials and methods

- PBF-LB/M process of AlSi10Mg and Alloy 718 was carried out using an AconityMIDI system
- Thermal monitoring was conducted using the thermographic camera Optris PI 640i
- Emissivity values of the as-built surface were determined using the same setup used in the manufacturing process (AlSi10Mg: $\varepsilon = 0.13$; Alloy 718: $\varepsilon = 0.36$)
- Specimen design was chosen to provoke overheating and shrinkage
- 3D scanning was performed using GOM Atos Core 200, and distortion was measured on the outer surface of all specimens
- Relative density was analyzed using metallographic preparation and microscopy

Specimen design and process setup



Results

Thermographic imaging

- Increasing the pin structure height results in higher part temperatures
- Part temperature strongly depends on the thermal properties of the material used
- Part temperature for AlSi10Mg saturates for increasing the pin structure height
- Reduction of Laser power in the bulk region only leads to a slight decrease in part temperature for Alloy 718
- Part temperature affects surface condition and, consequently, emissivity

Distortion measurement

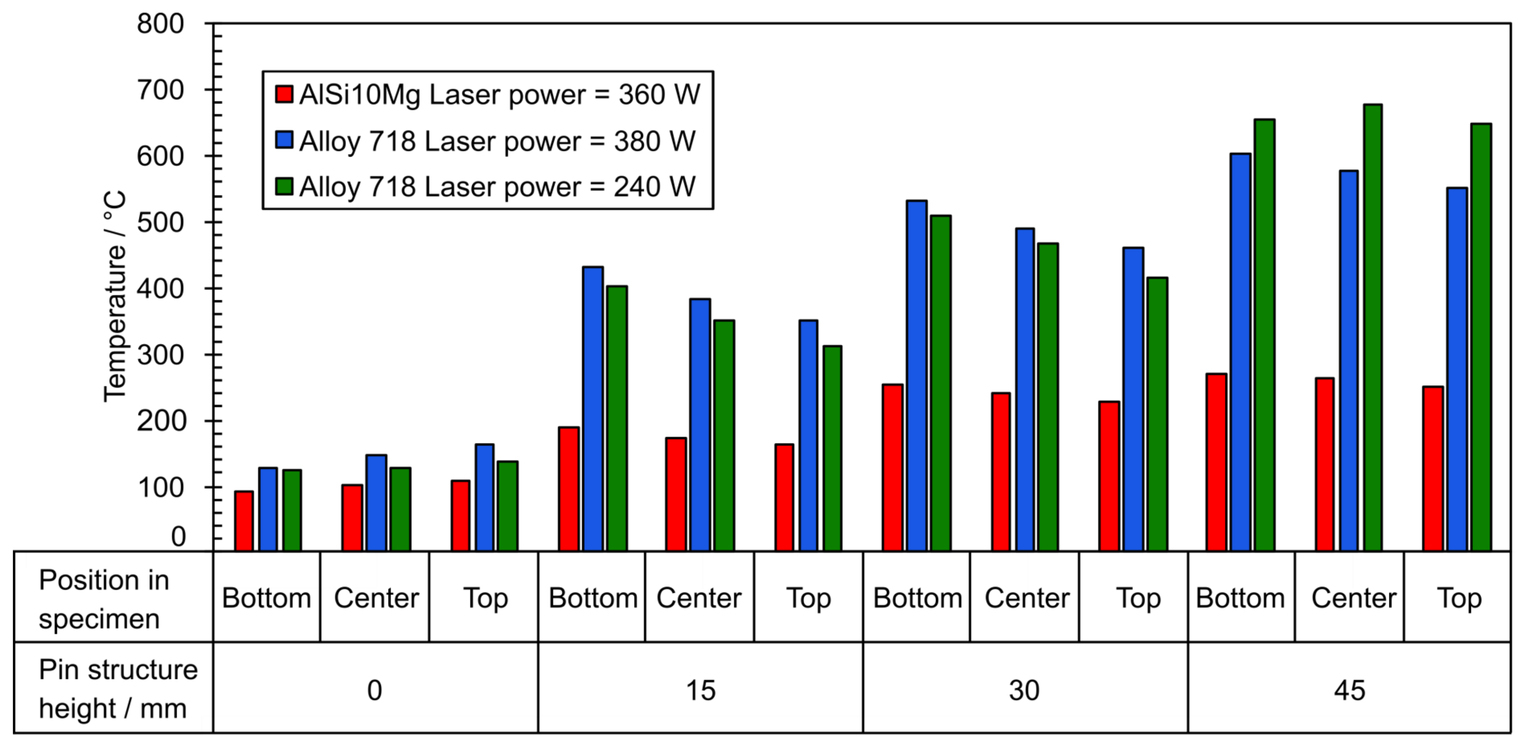
- Significant shrinkage occurs in the transition zone between the pin structure and the bulk
- AlSi10Mg: Shrinkage saturates with increasing pin height, likely due to its material properties and the corresponding part temperatures
- Alloy 718: A greater height of the pin structure leads to higher distortion. The reduction in Laser power results in up to 29 % less shrinkage

Relative density analysis

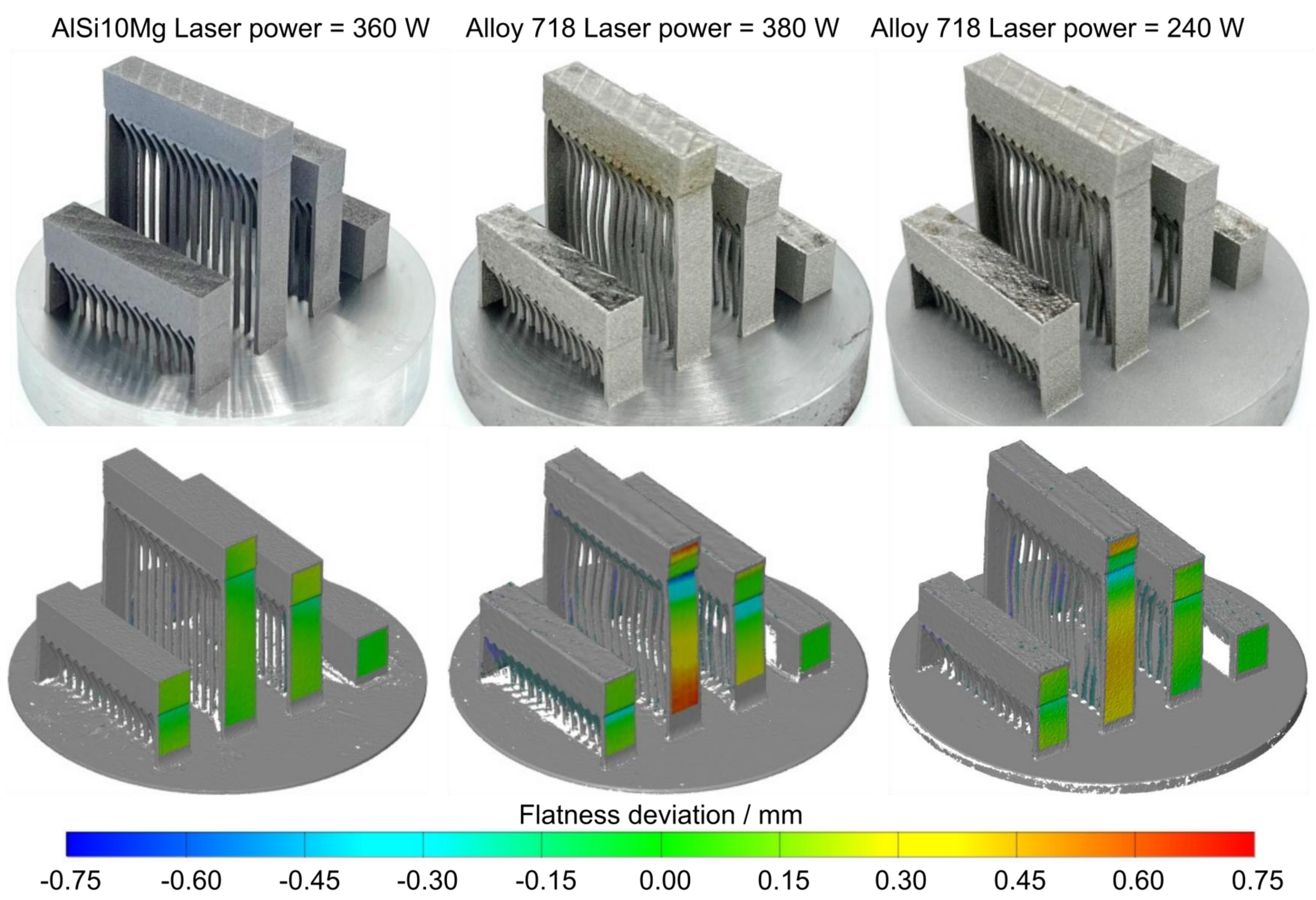
- Most specimens achieved high relative densities (~99.9 %)
- Without sufficient overheating, decreased Laser power is unsuitable for manufacturing Alloy 718 (due to lack of fusion)

Parameter adaptation based on overheating of the part can be an effective strategy to improve part quality in PBF-LB/M

Measured part temperature 1 s after exposure in the bottom, center, and top sections of the bulk



Photos (top) and 3D-scan with measured flatness deviation (bottom) of the built specimens



Achieved relative densities in the bulk region of the built specimens

Material	Laser power / W	Pin structure height / mm			
		0	15	30	45
		Mean relative density / %			
AlSi10Mg	360	99.90	99.94	99.86	99.89
Alloy 718	380	99.94	99.99	99.98	99.97
Alloy 718	240	99.27	99.97	99.98	99.98

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