

Effect of scan strategy and laser parameters on roughness of SLM AISi10Mg thin-wall

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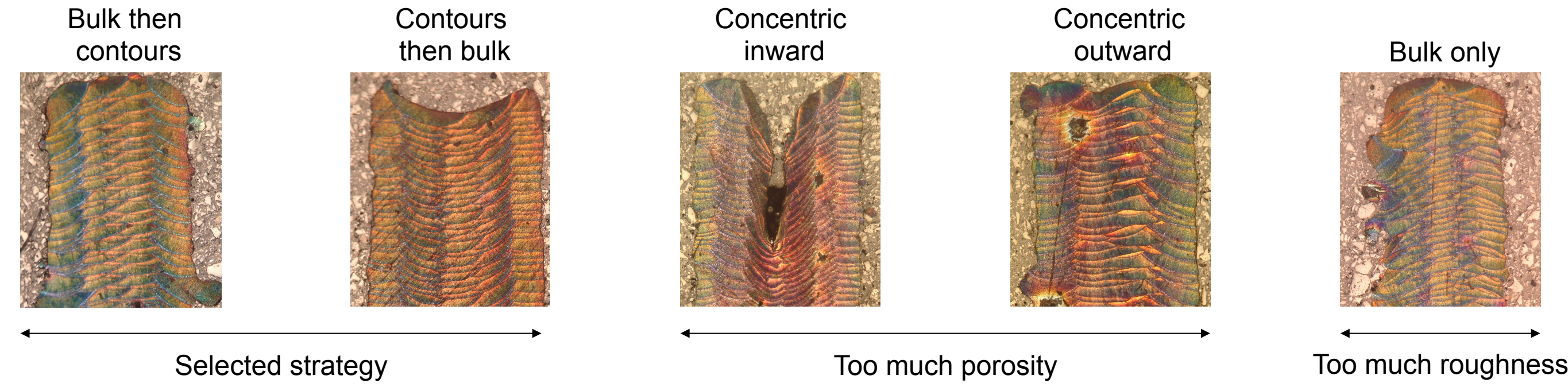
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Abstract

In aeronautics, selective laser melting (SLM) brings a new field of geometry optimization allowing a reduction of the weight and an improvement of the efficiency of aircraft pieces like heat exchangers or lattice structure [1]. Geometry optimization leads to complexe design with many thin elements whose roughness could be an issue. In this context, this work shows how laser parameters and scan strategies have an impact on the roughness of thin elements like thin walls. AISi10Mg 3D-Printed thin walls (600 μm -thick) were thus fabricated with a set of varying parameters such as the laser power, the scan speed and scan strategies. This work also attempts to understand how roughness appears during the process in order to be able to tune it.

Introduction

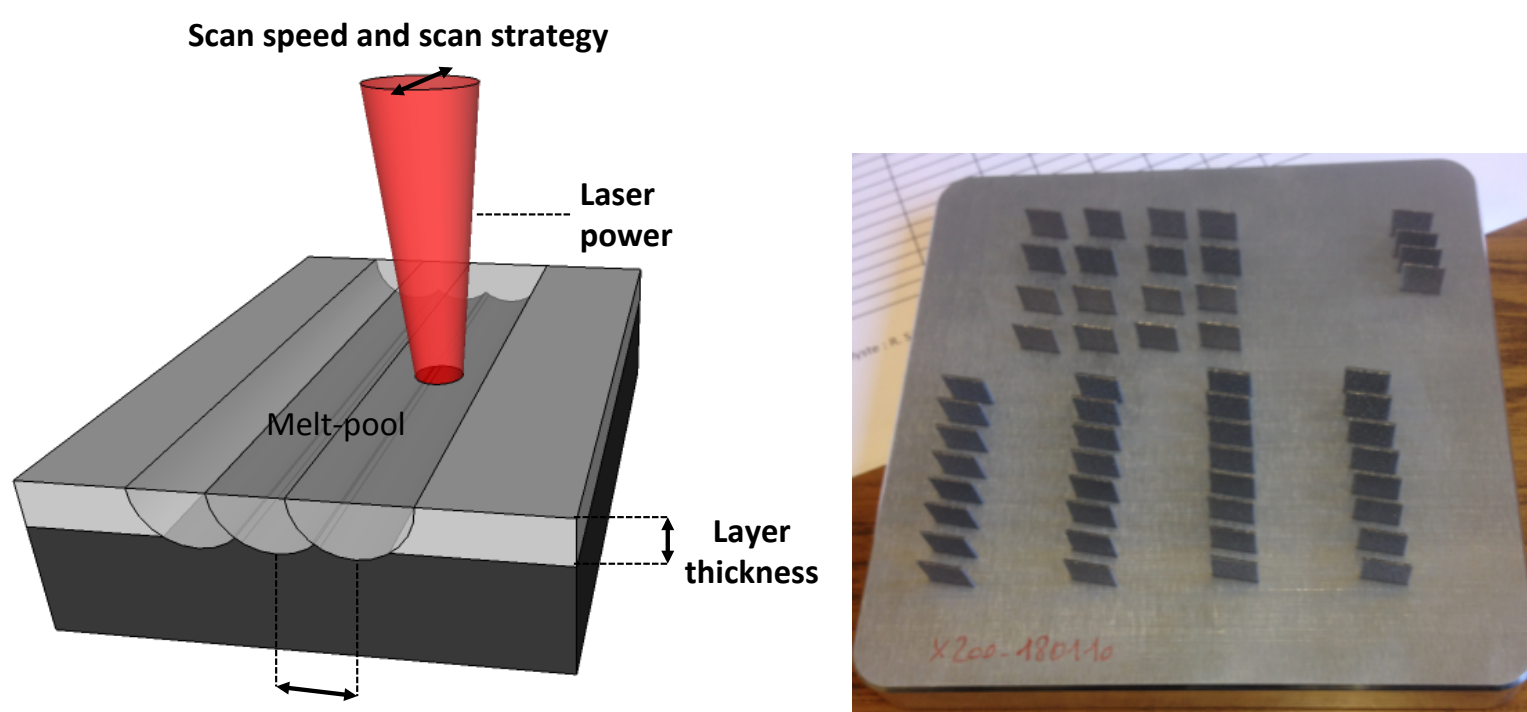
- Thin-walls are defined as walls with a thickness $\leq 1 \text{ mm}$ (typically 3-4x the width of a melt-pool)
- Starting parameters were chosen to be the optimized bulk-parameters (based on a density study on cube)
- Two relevant scan strategies were chosen through a preliminarily study:



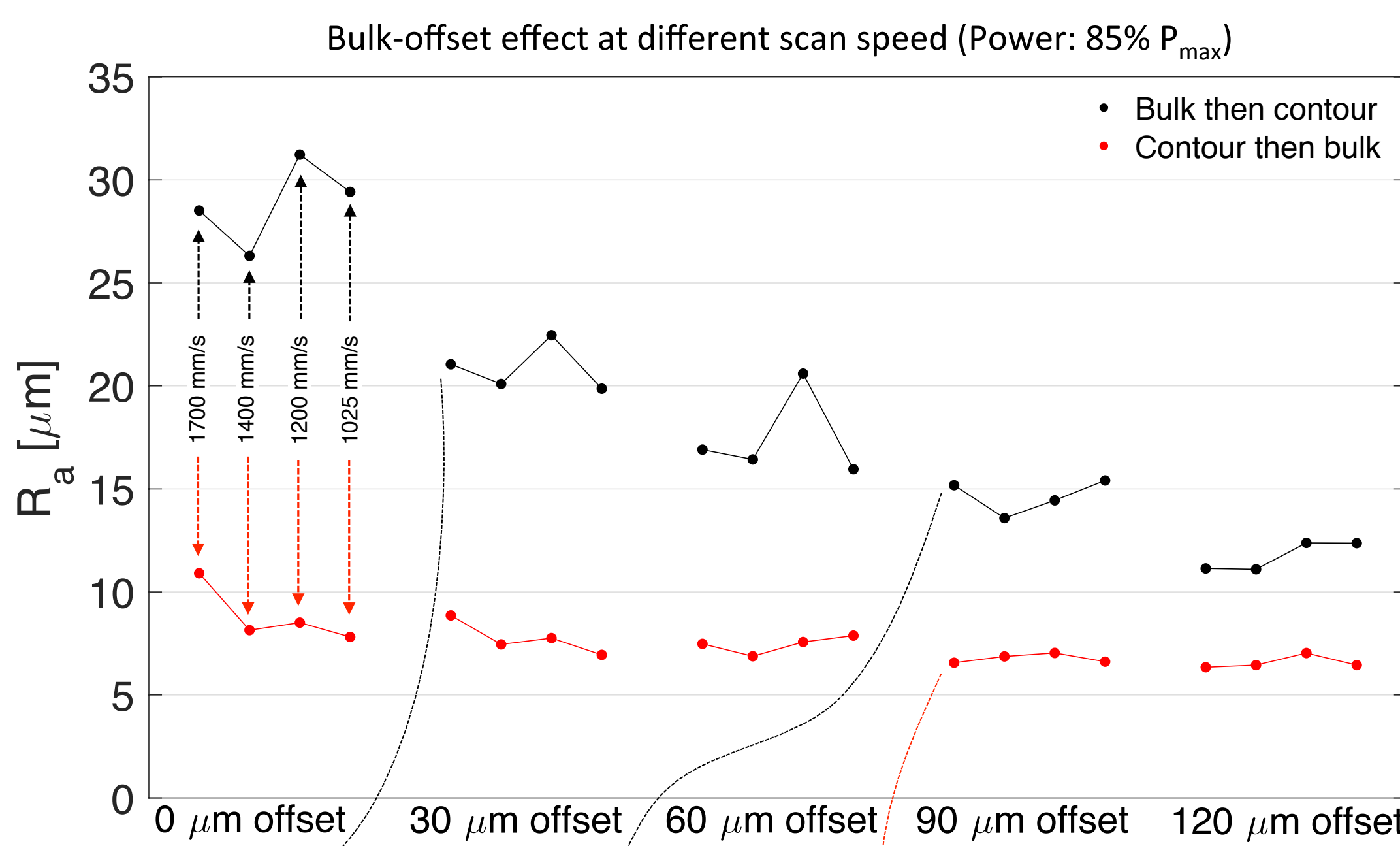
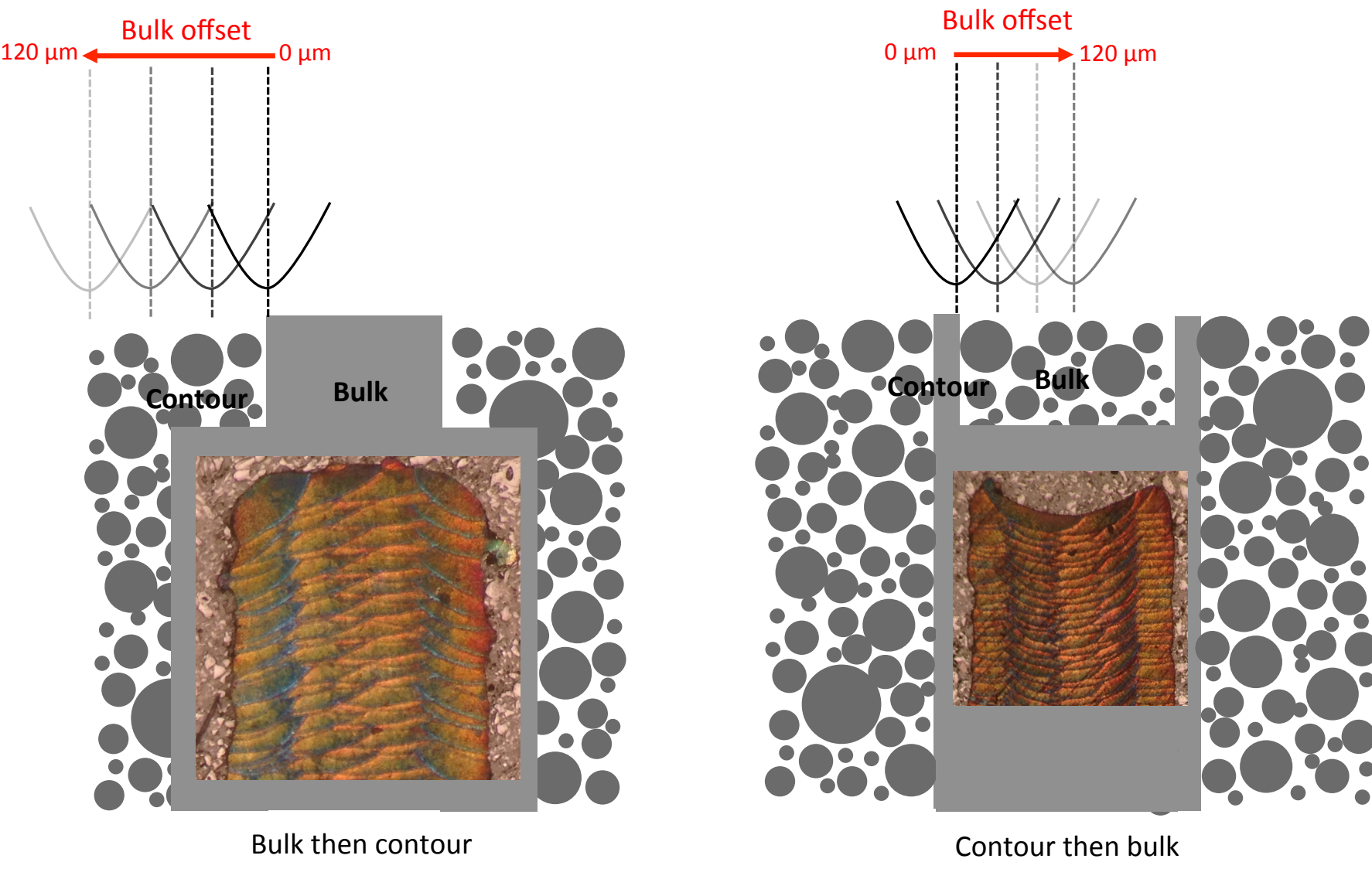
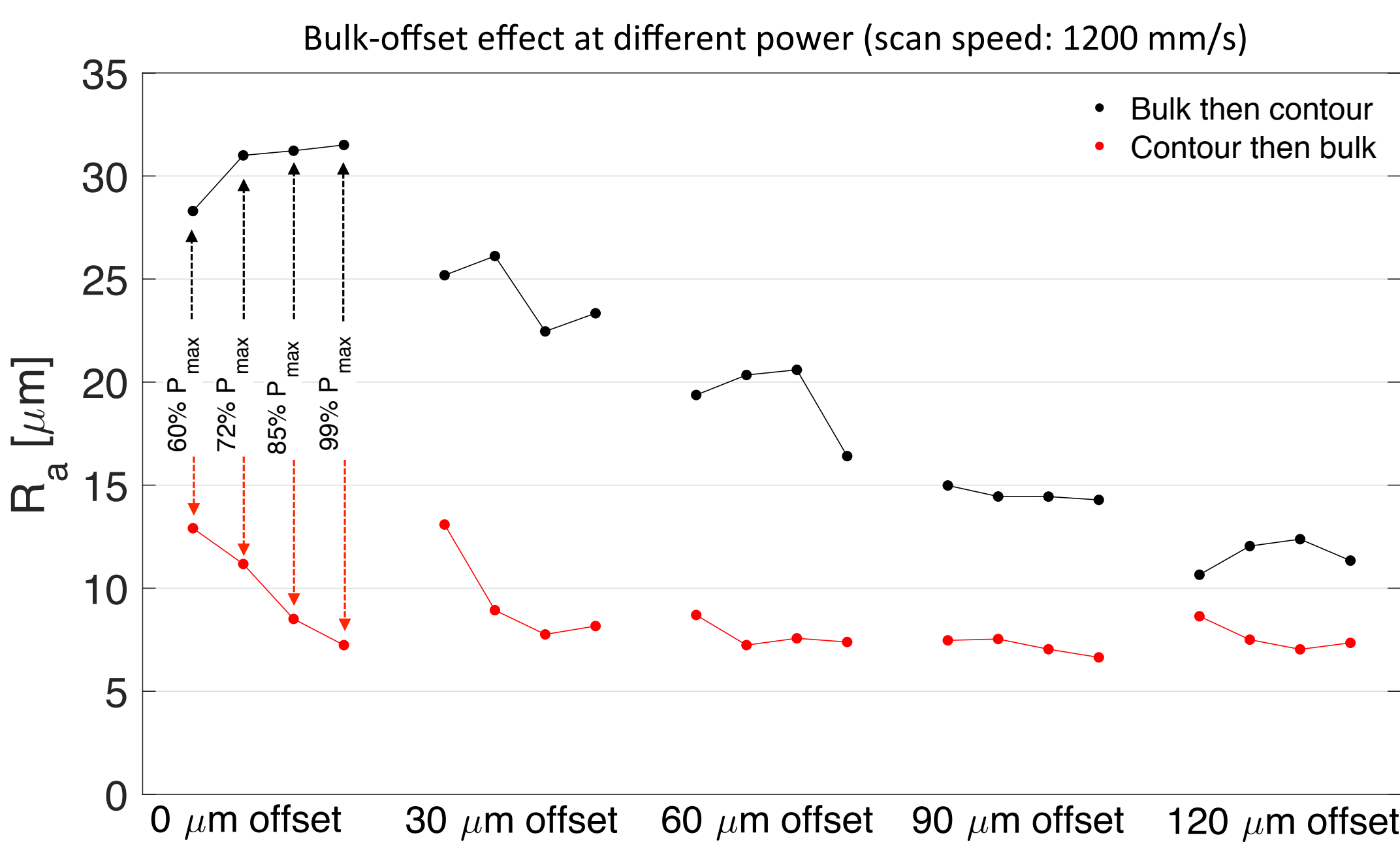
- Targetted contour parameters: scan speed, power and bulk offset (distance between contour and bulk)
- Roughness is measured by white light interferometry

Main parameters

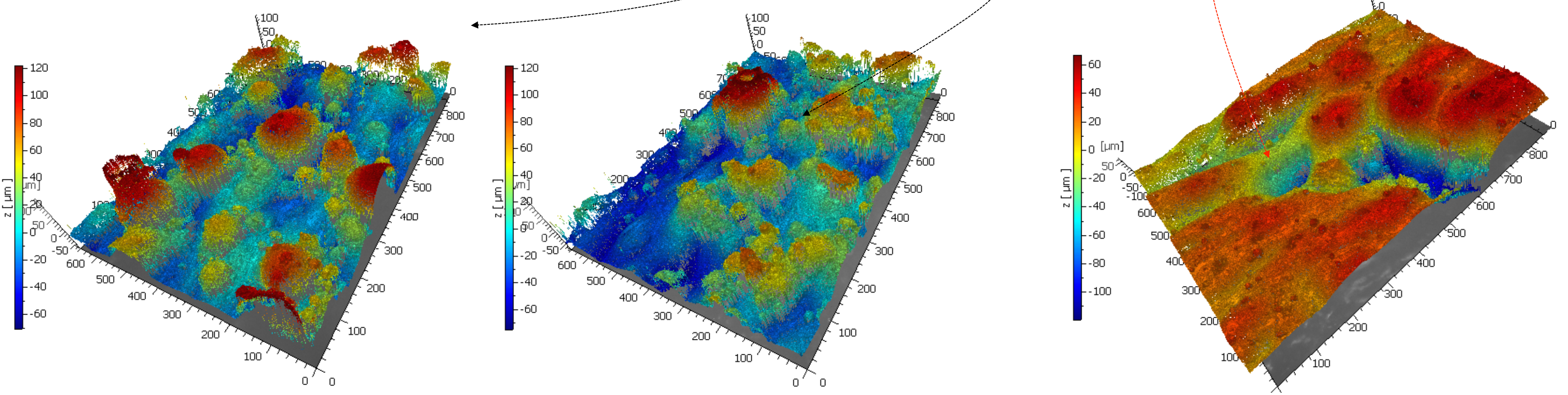
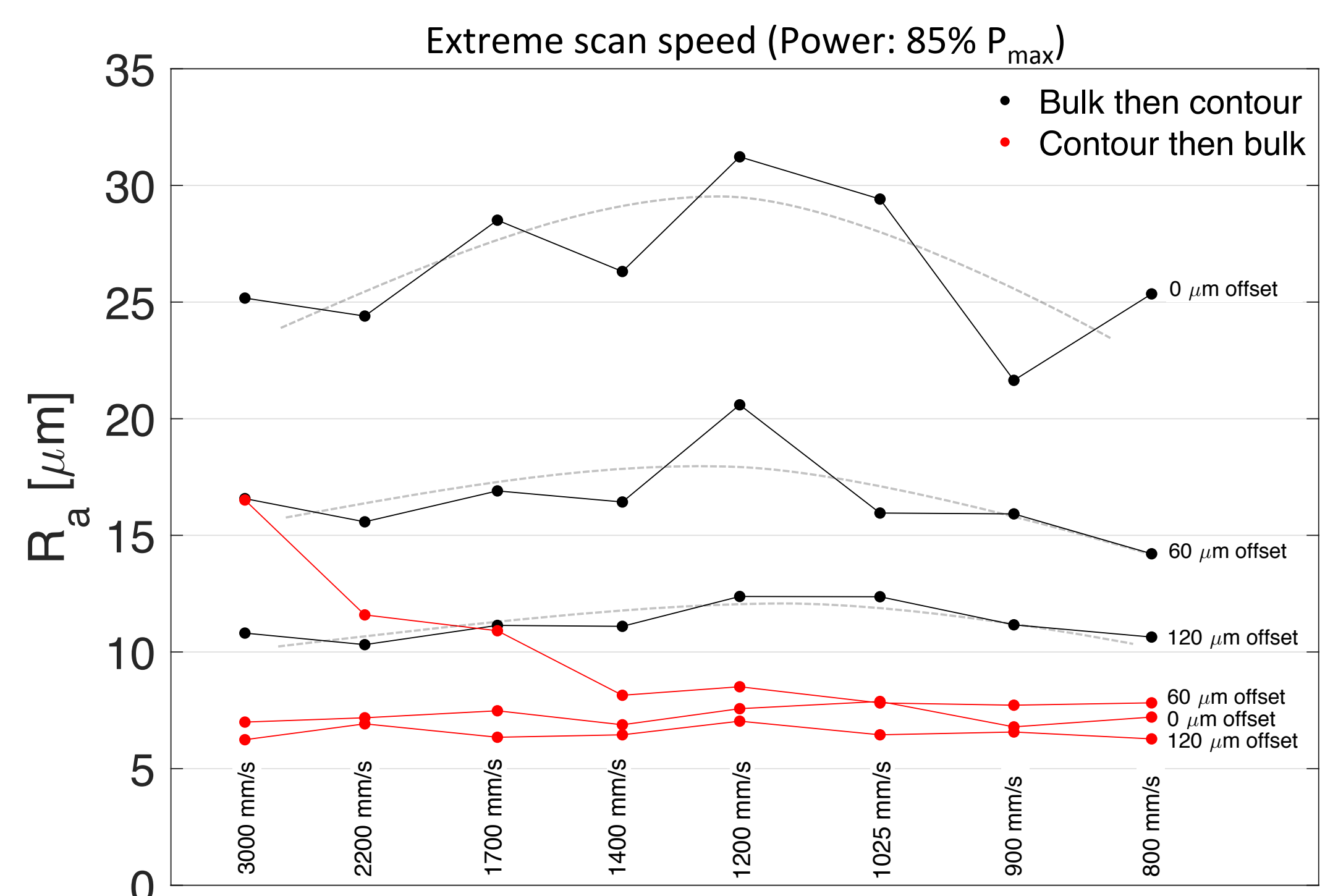
- Equipment: this work was runned on a 3D-systems printer with a 273.6 W-power laser
- Material: AISi10Mg
- Bulk (or core) parameters: speed: 1200 mm/s
power: 85%
hatching: 100 μm
layer thickness: 30 μm
resulting VED: 64.6 J/mm³
- Contour (or edge) parameters: variable
- Scan strategy: bulk then contours or contours then bulk.
Rotation between two bulk layers
- Thin-wall dimensions: 1cm x 1cm, 600 μm -thick



Results



- The bulk offset parameter has a first order effect when the strategy « bulk then contour » is used
- Effect of power and scan speed is not clear unless at low offset for « contour then bulk » strategy



- Different strategies lead to different roughness profiles
- The strategy « contour then bulk » is always better for decreasing the roughness



- In « bulk then contour strategy, melt-pools of contour tend to flow outward, increasing the roughness
- In « contour then bulk » strategy, bulk melt-pools are contained between the contour, flowing then inward and limiting the roughness

Conclusion

- The strategy « contour then bulk » is preferably used to decrease the surface roughness of thin-walls
- The bulk-offset parameter is a first-order parameter to control the roughness in « bulk then contour » strategy
- Laser power and scan speed are second-order parameter to control the roughness
- Roughness profile depends on the strategy used

Further work

- Study the effect of multiple contour strategies to decrease the roughness
- Effect of the roughness profile on mechanical properties (fatigue)
- Study the defect/porosity brought by the different contour strategies/parameters

References

[1] Delroisse P., Jacques P. J., Maire Eric., Rigo O., Simar A., Scripta Mater. 141 (2017) 32-35

Acknowledgements

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