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# Reduction of local overheating in selective laser melting

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The problems associated with local overheating during Selective Laser Melting (SLM) were often observed recently [1, 2]. If local overheating occurs, large molten zones above the building surface can arise. Such molten zones collide with the recoating blade and as consequence cause its damage and/or process break-off. An example of local overheating is shown in Figure 1. The geometry from Figure 1 is manufactured from a nickel-based superalloy with a standard additive manufacturing (AM) process. In our process the AM layers have 20 µm thickness. To avoid process interruption due to overheating we use flexible silicone rubber lip instead of hard recoating blade. Figure 1 demonstrates that the heat from the corners of the considered geometry cannot be transported appropriately. Therefore these corners are about 360 µm higher than the rest of the top surface. Such high molten zones not only cause blade crashes, but they are also inacceptable for quality control.

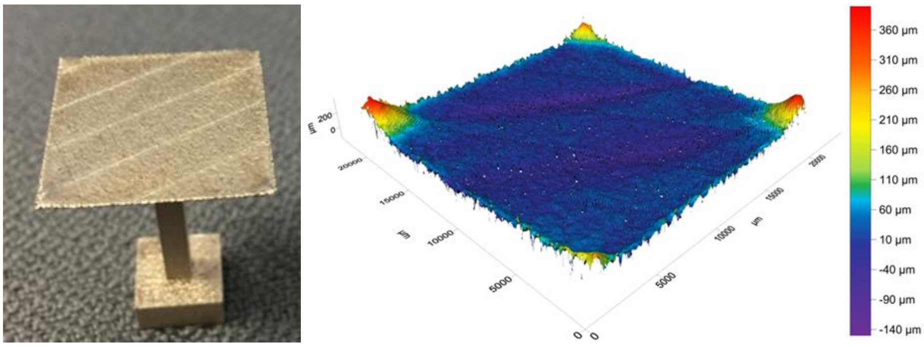
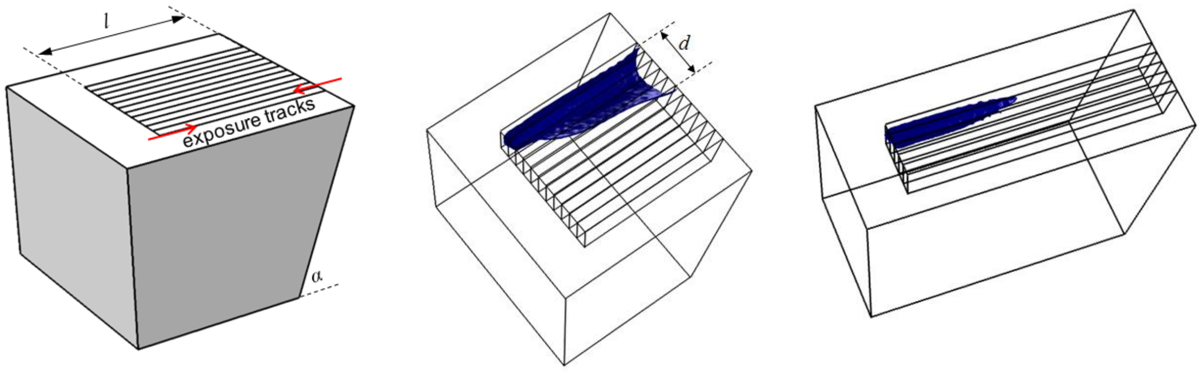



Figure 1: SLM geometry build with a standard process and its top surface profilometry

To identify critical areas in the AM process we simulate melt pools for representative volume elements (RVEs) shown in Figure 2. The slope angle $\alpha$ of RVEs is chosen identical to the slope of the geometry from Figure 1. RVEs with various lengths $l$ are simulated in order to illustrate the different blocked paths of the laser beam. For an overheated area as in Figure 2(b), the melt pool spreads over multiple tracks, so that a large molten zone is formed. From the simulated width of this zone an estimation of the corresponding elevation of the top surface can be done. Figure 2(c) shows, that in outside the overheating area, the melt pool size follows the expectation.




(a) (b) (c)

Figure 2: RVE element (a), typical melt pool for the area with (b) and without (c) overheating

Attempts to simulate melt pool size and update AM process parameters in order to reduce overheating were previously made, e.g., in [3]. The authors raise the velocity of laser beam layerwise depending on the slope angle. In opposite to [3], we identify critical areas by sample RVE simulations and reduce power input only in these areas. We tested the identification of critical regions for overheating on the geometry illustrated in Figure 1. We identified the size of the area around corners where the process parameters should be changed. We manufactured the inner volume of the reference geometry with the same AM parameters as above and reduced the power input in the corners. Figure 3 shows the result of this strategy. From Figure 3 it is clear that with our strategy we significantly reduced the overheated areas.

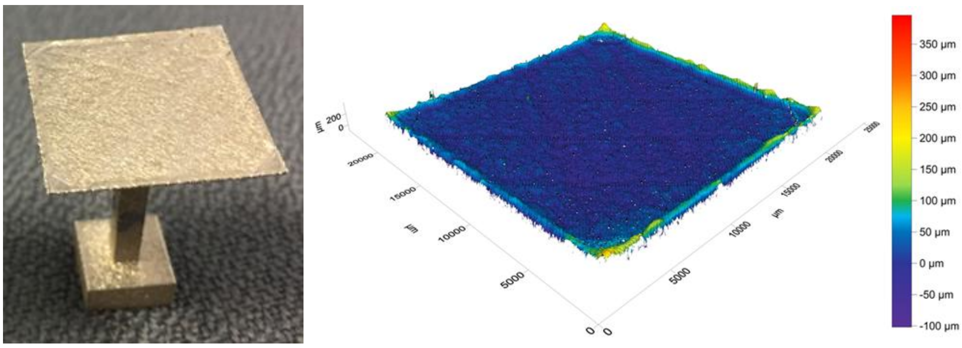



Figure 3: Reference geometry build with reduced power level in the corners and corresponding profilometry

In summary, we developed a method for systematic simulation of local overheating. It identifies critical areas that might cause AM process crashes. The method was successfully demonstrated on the reference geometry.

## References

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