CASE STUDY

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Bruker's 3D Optical Metrology technology optimises process control and new product development in Additive Manufacturing. Uniquely, we exploit both interferometry proven for fast repeatable metrology on even the smoothest of microstructure finishes and new focus variation algorithms for highest speed measurement of shape, forms and roughness.

Contour 3D Optical Profiler Case Study

Quantifying Selective Laser Melting Process differences

Selective laser melting techniques (SLM) requires adjustment of laser beam power, spot size and scanning speed to ensure adequate melting of the complete bed layer in Additive Manufacturing (AM). Process parameters are highly dependent on powder chemistry. Bruker's Contour 3D optical profilers enable process optimisation through complete analysis of 3D surface microstructure parameters.

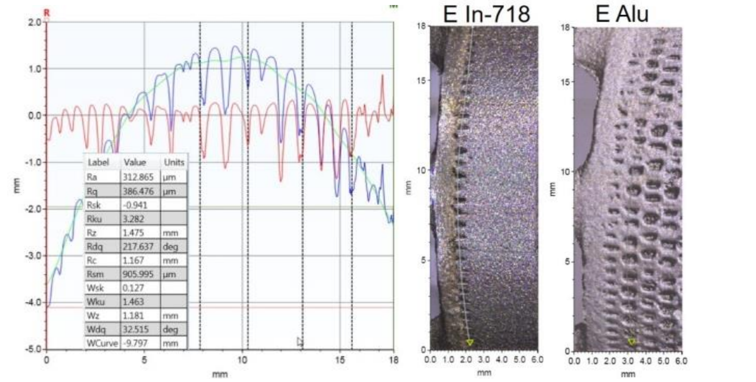


Figure 1: Extraction of shape, waviness and roughness on Inconel powder manufactured ring by LSM. Right hand image shows corresponding part made from aluminium

Figure 1 identifies key difference between SLM manufactured ring parts using Inconel 718 and Aluminium powders. The Aluminium ring still exhibits unmelted or partially melted particles resulting from too low laser power or too fast laser scanning while the Inconel ring exhibits a uniform melting front confirming optimised laser settings.

In addition to providing a powerful 3D visualisation of morphology differences, the Contour Optical Profiler quantifies and ranks process quality through advanced roughness S parameters from ISO norm 25178. This drives iterative optimisation of process conditions. The following specific parameters best discriminate between Al and Inconel based process:

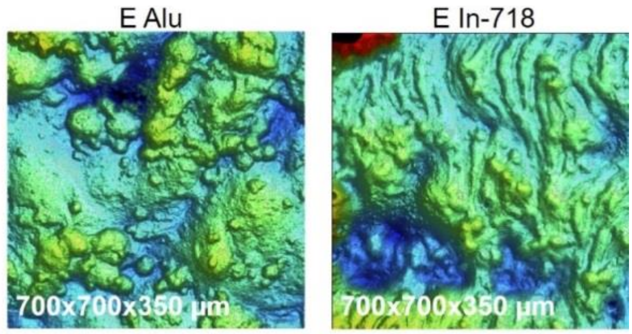
Ssk (Skewness) quantifies the degree of symmetry above/below the mean plane characterizing the number of extreme peaks or valley structures. A Zero value stands for perfect symmetry while a negative value indicates a higher number of cavities/pores and a positive value emphasizes a predominance of unmelted particles

Sdr expresses how corrugated/porous the surface is.

Ssc is the Mean Summit Curvature for the various peak structures revealing presence of aggregated or partially melted particles.

Sm represents the mean spacing between asperities or spikes.

The surface from the Inconel ring is indeed smoother (Figure 2) resulting from optimized process conditions delivering improved fusion of the particle bed. Specifically, it exhibits (a) lower corrugation evidenced from Sdr differences, (b) a flatter surface with longer radius of curvature proved by 60% higher Ssc, and (c) contains longer spacing between asperities/spikes proved by the 57% larger Sm value.



	Height	Hybrid		Functional
	Ssk	*Sdr*	*Ssc (nm-1)*	*Sm (µm)*
E Alu	-0.61	182	1.3E-03	1.15
E IN718	0.84	120	3.2E-03	2.68
Difference	173%	-51%	60%	57%

Figure 2: 3D surface morphology of comparison between Aluminium and Inconel manufactured rings

Bruker's VisonMap64 software enables immediate databasing of all those key roughness parameters making possible to build custom experimental models. Modelling then provides a faster time to accurate results without blind trial & error process changes.

The high accuracy data from Bruker's Contour 3D Optical Metrology systems combined with automated analysis and databasing enables immediate identification of issues with Additive Manufacturing processes. This helps accelerate R&D for next generation AM structures.

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