SURFACE ROUGHNESS – MECHANICAL PROPERTIES

Additive manufacturing (AM) is gradually establishing itself in the production of complex-structured components. Beyond the utility value of design freedom, the target-effective use of materials in a relatively short time is decisive. Dynamic material loads correspond to the reality-oriented use case and are strongly affected by the surface topology. In particular, the nickel-based alloy Inconel 718 is primarily used in propulsion technology and is therefore subject to a relatively frequent peak load within the product life cycle. Synergetically, a next step includes the identification of a cost-efficient post-processing with increased build-up rate.

PROJECT OVERVIEW

DURATION

6 months

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Motivation

The surface of additively manufactured components in the “as printed” state is already of a relatively high quality due to the coordination of process parameters concerning the process and material. Nevertheless, post-processing of the surface is unavoidable and requires the commitment of time resources.
Since the process duration is strongly dependent on the parameter sets used, the question arises as to whether an increased build rate with slight losses in surface quality compensates for the time required for the obligatory post-processing.

Aim

A “high-productivity” build rate, with slightly reduced surface quality, means that less machine time is tied up in the build process. A more detailed rework is usually more cost-effective to fulfil the mechanical requirement profile of the component. Finally, a comparison of parameter selection and rework methodology should provide information about the dynamic material behaviour.

Experimental

Following DIN EN ISO 6892 and ISO 12106, the additive manufacturing of specimens from the nickel-based material Inconel 718 - material number 2.4668 is carried out by means of laser beam melting with the additive manufacturing system from SLM Solutions type 280HL stationed at the DMRC. Two different sets of parameters are used, which should differ in terms of the build-up rate. Basically, the layer height (slicing) and the applied laser power are affected. It is expected that with a “high-productivity” approach, the surface quality will be reduced in favour of the production time. At the end of the generative phase of the project, the specimens are machined using various post-treatment methods, such as barrel finishing. Post-processing is used to compensate for surface defects in the contour to minimise the susceptibility to failure for dynamic loads. The differently treated specimens are examined with regard to their surface roughness and provide, in the first instance, an analytical formulation of the service life expectancy. The surface roughness is recorded at the DMRC using optical digital macroscopy. The VR-3100 3D measuring macroscope from

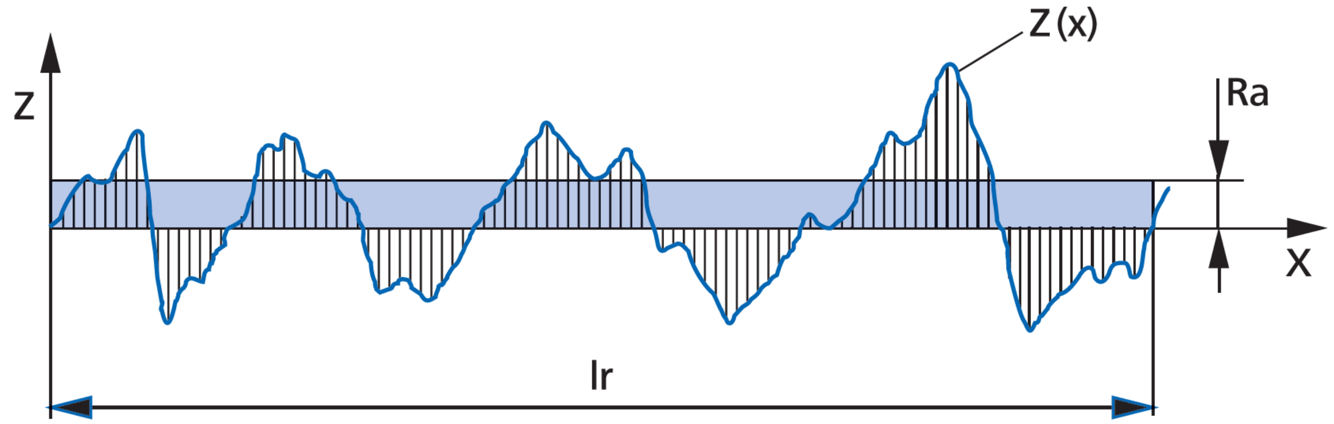

FIGURE 1 Arithmetischer Mittenrauwert

Keyence is used for this purpose to enable comparability of the surfaces.

After completion of the post-processing and its preliminary analysis, the mechanical behaviour of the modified surfaces is recorded by quasi-static and dynamic test methods. The “high-productive” specimens should show at least the same results regarding the material characteristics in the quasi-static and dynamic profile. Based on the quantified characteristic values, it can be deduced which synergetic effect results from the change of parameter sets in the AM range and the choice of a specific post-processing method for the surface. This is based on the influence of the characteristic material behaviour to determine to what extent the different production approaches change the strength and durability.

With the comparison of the final results, it can be deduced whether the reduced surface quality in favour of the construction rate represents a cost- and especially time-optimised approach. Constant performance of the material with modified parameters, compared to a proven standard construction method, is the minimum goal.