In-situ thermographic monitoring of the laser metal deposition process

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ABSTRACT

By allowing economic on demand manufacturing of highly customized and complex workpieces, metal based additive manufacturing (AM) has the prospect to revolutionize many industrial areas [1]. Since AM is prone to the formation of defects during the building process, a fundamental requirement for AM to become applicable in most fields is the ability to guarantee the adherence to strict quality and safety standards. A possible solution for this problem lies in the deployment of various in-situ monitoring techniques. For most of these techniques, the application to AM is still very poorly understood [2]. Therefore, the BAM in its mission to provide safety in technology has initiated the project "**Pro**cess **Mo**nitoring of **AM**" (ProMoAM). In this project, a wide range of in-situ process monitoring techniques, including active and passive thermography, optical tomography, optical emission and absorption spectroscopy, eddy current testing, laminography, X-ray backscattering and photoacoustic methods, are applied to laser metal deposition (LMD), laser powder bed fusion and wire arc AM. Since it is still unclear which measured quantities are relevant for the detection of defects, these measurements are performed very thoroughly. In successive steps, the data acquired by all these methods is fused and compared to the results of reference methods such as computer tomography and ultrasonic immersion testing. The goal is to find reliable methods to detect the formation of defects during the building process. The detailed acquired data sets may also be used for comparison with simulations.

Here, we show first results of high speed (> 300 Hz) thermographic measurements of the LMD process in the SWIR range using 316L as building material. For these experiments, the camera was mounted fixed to the welding arm of the LMD machine to keep the molten pool in focus, regardless of the shape of the specimen. As the thermograms do not contain any information about the current spatial position during the building process, we use an acceleration sensor to track the movement and synchronize the measured data with the predefined welding path. This allows us to reconstruct the geometry of the workpieces and assign the thermographic data to spatial positions. Furthermore, we investigate the influence of the acquisition wavelength on the thermographic data by comparing measurements acquired with different narrow bandpass filters (50 nm FWHM) in a spectral range from 1150 nm to 1550 nm.

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REFERENCES

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