Application of Electromagnetic Methods to Residual Stresses in Additive Manufacturing: Potential and Necessary Development

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Keywords: additive manufacturing, LPBF, SLM, SS316L, electromagnetic, barkhausen noise, eddy current, XRD, hole drilling

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Laser based additive manufacturing (AM) of metallic parts induces high residual stresses in the material, due to high thermal gradients during processing. Such residual stresses are detrimental to the part integrity and its mechanical performance and can lead to part deformation during and after the manufacturing process. Electromagnetic (EM) sensing methods such as Barkhausen Noise and Eddy current have shown capabilities of measuring residual stress states in metallic materials.

However, so far, no studies have been focusing on the combination of AM and EM to monitor the residual stresses state during, or after the manufacturing process. This study focusses on the analysis of potentails and limitations of such methods and approaches; by the investigation of AM samples manufactured in stainless steel 316L and a hot tooling steel maraging steel 300.

The stainless steel samples, one being stress relieved after a heat treatment, are analysed successively using an inductive measurement, and Eddy current. Further, the samplesare compared to residual stresses analysed by the hole drilling method. Results indicate that the inductive method is sensitive to the stress state on multiple frequencies, while ECwas not sensitive enough.

Furthermore, the hot tooling steel samples are scanned with a Barkhausen Noise sensor and an EC sensor; subsequently measured by X-Ray Diffraction and the hole drilling method. The Barkhausen noise measurement showed variation in the signal on different locations showing some potentials for future measurments, while.the EC technology showed some sensitivity.

Theses results are promising to start further experiments with electromagnetic methods on AM parts. Opening thereby a new field for closed loop control of metal-based AM-processes

Acknowledgments: The authors would like to acknowledge the company Stresstech GmBh for its support in this pre-study.