

Table of Contents

Abstract/Kurzzusammenfassung V

Table of ContentsVII

List of Publications..... IX

Nomenclature XIII

Formula Symbols XV

List of Figures XVIII

List of Tables..... XXXI

1 Introduction and Motivation 1

2 Literature Review and Theoretical Background 7

2.1 Laser-Based Powder Bed Fusion of Metals (PBF-LB/M)..... 7

2.2 Deformation Mechanisms..... 20

2.3 Solidification Behavior of Metals in Additive Manufacturing..... 24

2.4 Fundamental Considerations on the Fatigue of Metallic Materials..... 34

2.5 Defect Tolerance under Different Loading Conditions 42

3 Experimental Details..... 48

3.1 Feedstock materials 48

3.2 Manufacturing of Specimens..... 53

3.3 Microstructural Characterization 55

3.4 Mechanical Characterization 56

4 Results and Discussion 59

4.1 Process Interruptions in PBF-LB/M 59

4.1.1 Results of a Process Interruption on an Aluminum-based Alloy 60

4.1.2 Results of a Process Interruption on an Iron-based Alloy..... 71

4.1.3 Discussion on Process Interruption in PBF-LB/M..... 83

4.2 Processability of Spattered Powder in PBF-LB/M..... 94

4.2.1 Results on the Utilization of Spattered Powder for an Aluminum-based Alloy 95

4.2.2 Results on the Utilization of Spattered Powder for an Iron-based Alloy..... 101

4.2.3 Discussion on the Utilization of Spattered Powder Feedstocks 111

4.3 Influence of Process Gas Velocity on the Part Quality 119

4.3.1 Results of Variable Process Gas Velocities for an Aluminum-based Alloy 121

4.3.2 Results of Variable Process Gas Velocities for an Iron-based Alloy..... 128

4.3.3	Discussion on the Influence of Inert Gas Flow in PBF-LB/M.....	135
4.4	Transfer to Electron-Based Powder Bed Process	144
5	Summarizing Discussion	163
5.1	Sensitivity of Materials.....	163
5.2	Overall Performance of the Investigated Materials	168
5.3	Influencing Material Properties on the Processability and Robustness of Production..	175
6	Summary and Outlook	185
7	References.....	188
	Appendix	231