Table of contents

List of figures ..... **xv**
List of tables ..... **xxiii**
Nomenclature ..... **xxv**
1 Introduction **1**
2 State of knowledge **5**
2.1 Bubble column reactors 6
2.1.1 Operating modes 8
2.1.2 Most important design parameter for bubble columns 12
2.1.3 Process intensification 17
2.1.4 Structuring of bubble columns 18
2.1.5 New degrees of design freedom through Additive Manufacturing 21
2.2 State of the Art: Additively Manufactured Lattice Structures 24
2.3 Mass transport in gas- liquid systems 28
2.3.1 General modeling 28
2.3.2 Influence of AMLS on the boundary layer 33
2.3.3 Influence of AMLS on the specific interfacial area 36
2.3.4 Influence of AMLS on the residence time 39
3 Experimental setups and procedures **41**
3.1 30x30 mm² square flow channel setup 41
3.1.1 Gas holdup measurements 42
3.1.2 Mass transport investigations (stationary method) 44
3.1.3 Determination of bubble sizes and distributions (optically) 45
3.1.4 Pressure drop investigations 47
3.2 DN 110 flow tube setup 49
3.2.1 Needle probe (A2PS) 49
3.2.2 Electrical capacitance volume tomography (ECVT) 54

4 Results and discussion 63
4.1 Influence of AMLS on gas holdup and bubble size distribution 63
4.1.1 Tailoring local gas holdup distribution through AMLS 63
4.1.2 Tailoring bubble size distribution through AMLS 75
4.2 Influence of AMLS on bubble velocity and residence time 77
4.3 Influence of AMLS on the two-phasic pressure drop 79
4.4 Influence of AMLS on transport properties ($k_L a$) 82
4.4.1 Influence of fluid velocities on mass transfer 83
4.4.2 Gas holdup 86
4.4.3 Specific interfacial area 89
4.4.4 Residence time 92
4.4.5 Conclusion 95
5 Smart Structures 97
5.1 Stimuli-Responsive Polymers 97
5.2 Stimuli-Responsive Hydrogels 99
5.3 Additively Manufactured Hydrogels 99
6 Conclusion and outlook 104
Bibliography 107
Appendix 117