

Contents

1	Introduction	1
	References	3
2	Theory of Holography	5
2.1	Properties of Light Waves	5
2.1.1	Intensity	5
2.1.2	Interference	6
2.1.3	Coherence	6
2.1.4	Diffraction	6
2.2	Holography	6
2.2.1	Principle	7
2.2.2	In-line Holography	7
2.2.3	Numerical Reconstruction	9
2.2.4	Resolution	9
	References	10
3	State of the Art	13
3.1	Alga <i>Ulva linza</i>	13
3.2	Influence of Surface Properties on Settlement and the Adhesion Strength of <i>Ulva</i> Spores	17
3.2.1	Wettability	17
3.2.2	Ethylene Glycol Containing Surfaces Coatings	19
3.2.3	Lubricity	19
3.2.4	Charge	20
3.2.5	Topography	20
3.3	Motility of Microorganisms	21
3.3.1	Hydrodynamics Basics: Life at Low Reynolds Number [37]	22
3.3.2	Properties of Swimming Microorganisms	22
3.3.3	Hydrodynamics Interaction at Solid Boundaries	24

3.4	Tracking in 3D	27
	References	27
4	Experimental Details	31
4.1	Setup	31
4.1.1	Holographic Microscope	31
4.1.2	Wet Cell	32
4.1.3	Subsonic Noise Isolation	33
4.1.4	Data Acquisition Program	33
4.1.5	Heat Isolation	35
4.2	Experimental Procedure	36
4.3	Trajectory Analysis	37
4.3.1	Reconstruction	37
4.3.2	Position Determination	38
4.4	Trajectory Interpretation	42
4.5	Surface Position Determination	47
4.6	Experiments with <i>Ulva</i> Zoospores	49
4.7	Investigated Surfaces	49
	References	50
5	Results: Motility and Exploration Behavior of <i>Ulva</i> Zoospores . . .	51
5.1	Motility of <i>Ulva</i> Zoospores in Solution	52
5.1.1	Bulk Motility: Global Analysis of Traces	52
5.1.2	Bulk Motility: Detailed Motion Analysis for Individual Traces	57
5.1.3	Summary of the Motility in Solution	64
5.1.4	Discussion of the Motility in Solution	64
5.2	Surface Exploration	67
5.2.1	Standard Settlement Study	67
5.2.2	Expected Spore Settlement During a Holographic Tracking Experiment	68
5.2.3	Settlement Analysis on the Investigated Surfaces	69
5.2.4	General Exploration Patterns	72
5.3	Summary of the Results of the Surface Exploration	79
5.3.1	General Observations on Motility for All Investigated Surfaces	80
5.3.2	Summary of Results for the Exploration Behavior on AWG	81
5.3.3	Summary of Results for the Exploration Behavior on PEG	81
5.3.4	Summary of Results for the Exploration Behavior on FOTS	82
	References	83

6 Discussion of the Motility of *Ulva* Zoospores in Vicinity to Surfaces 85

6.1 Occurrence and Time Evolution of the Exploration 85

 Behavior in Vicinity to Different Surfaces 85

6.2 Deterrent Properties of the PEG Surface. 87

6.3 The *Hit and Stick* Pattern and Its Importance for the Observed High Amount of Settlement on FOTS 92

6.4 Hydrodynamic Trapping or Active Extended Exploration Near the Surface? 101

References 109

7 Conclusion and Outlook. 111

References 112

Appendix 115

Index 177