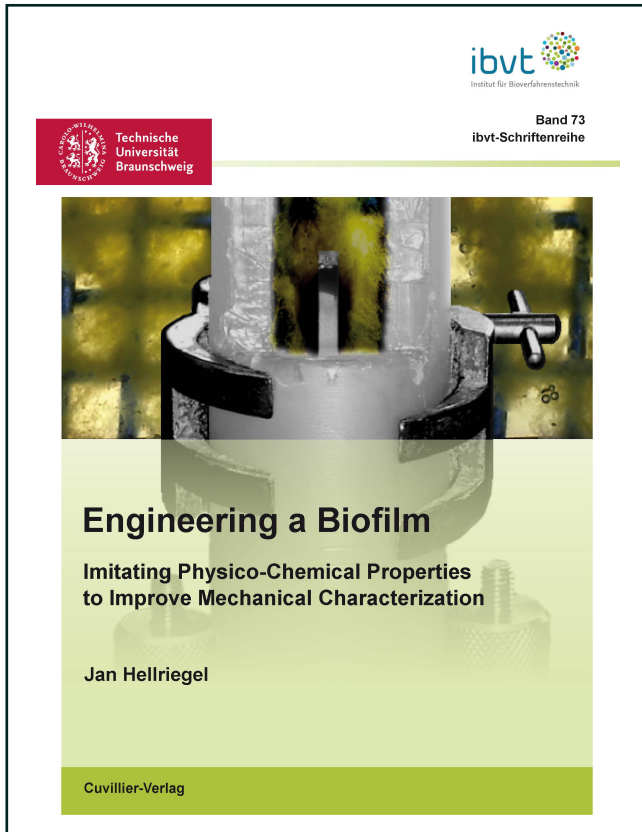




Jan Hellriegel (Autor)

Engineering a Biofilm

Imitating Physico-Chemical Properties to Improve Mechanical Characterization



<https://cuvillier.de/de/shop/publications/6722>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentzsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany
Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>



Contents

1	Introduction	1
1.1	Biofilms Today	1
1.2	Objectives	1
2	Theory	3
2.1	General Knowledge of Biofilms	3
2.1.1	Structure and Composition of Biofilms	3
2.1.2	Composition of the Extracellular Polymeric Substances	6
2.1.3	Biofilm Mechanics and Extracellular Polymeric Substances	7
2.1.4	Biofilm Detachment	9
2.1.5	Influence of Metal Ions	9
2.1.6	Basics on Batch, Continuous and Biofilm Growth Models	11
2.1.7	Physical Biofilm Models	16
2.2	Hydrogels	16
2.2.1	Properties of Gellan and other Biopolymers	17
2.2.2	Gellan Gelling Mechanisms	18
2.2.3	The Sol-Gel Temperature of Gellan-Based Hydrogels	21
2.2.4	Oxygen Diffusion in Hydrogels	21
2.3	Continuum Mechanics	22
2.3.1	Viscoelastic Model for Polymers	23
2.3.2	Worm-Like-Chain-Model	26
2.3.3	Measurement Techniques	26
2.4	Response Surface Methodology	28
3	Material and Methods	29
3.1	Cultivation	29
3.1.1	Cultivation Medium	29
3.1.2	Seed Cultures	30
3.1.3	<i>P. putida</i> KT2440 and <i>E. coli</i> K12 Biofilms Grown on Membrane Filter	30
3.1.4	Hydrogel with Immobilized <i>P. putida</i> KT2440	31



3.1.5	Cultivation in the Biofilm Tube Reactor	31
3.1.6	Genetic Strain Modification	33
3.1.7	Sample Preparation	35
3.2	Analytics	36
3.2.1	Calibration of Optical Density Sensor	36
3.2.2	Correlation of Optical Density and Bio Dry Weight	36
3.2.3	Calibration of pH Sensor	37
3.2.4	Calibration of Temperature Sensor	37
3.2.5	Calibration of Dissolved Oxygen Sensor	37
3.2.6	Oxygen Microelectrode Measurements	38
3.2.7	Rheology	38
3.3	Response Surface Methodology	39
3.3.1	Statistical Methods	40
4	Results and Discussion	43
4.1	Growth of <i>Pseudomonas putida</i> KT2440 on Different Media	43
4.2	GFP Producing Mutant of <i>P. putida</i> KT2440	45
4.2.1	Growth of <i>P. putida</i> KT2440 pSSBm85	47
4.3	BTR Cultivation and Biofilm Development	48
4.3.1	Cultivation in AB10 Medium with 4 mM Citrate	48
4.3.2	Cultivation in AB10 Medium with 10 mM Citrate	50
4.3.3	Cultivation in AB10 Medium with 10 mM Glucose	51
4.3.4	Cultivation in LB Medium	54
4.3.5	Concluding Comparison of Growth Media	55
4.3.6	Concluding Comparison of Biofilm Growth	56
4.3.7	Experiments with Detachment	60
4.3.8	Biofilm Mechanics	62
4.4	Biomimetic Gellan Based Hydrogels	66
4.4.1	Defining the Design Space	67
4.4.2	Amplitude Sweeps	68
4.4.3	Frequency Sweeps	70
4.4.4	Surface Response Methodology	73
4.4.5	Quality of the Model	78
4.4.6	Relaxation of Gellan	79
4.4.7	Influence of Sodium and Magnesium Ions on the Sol-Gel Temperature of Gellan Gum	81



4.4.8	Oxygen Diffusion in a Biomimetic Hydrogel	84
4.5	Proof of Principle	85
4.5.1	Worm-Like-Chain-Model for Gellan	88
5	Conclusion	93
A	Appendix	113
A.1	Modified BTR	113
A.2	Parameters of Maxwell-Wiechert-Model	114