

Contents

Abbreviations and List of Symbols	XI
Zusammenfassung	XV
Abstract	XIX
1 Motivation and Introduction	1
1.1 Fuel Cell Fundamentals	2
1.2 Fluid Transport in Porous Media	12
1.3 Outline of the Thesis	27
2 Simulation of Water Distribution	31
2.1 Simulated annealing	36
2.1.1 Validation of the approach	39
2.1.2 Parallel Simulated Annealing	43
3 Constitutive Relationships and Transport Parameters	53
3.1 Capillary pressure-saturation relationship	56
3.1.1 Experimental setup	56
3.1.2 Results	65
3.2 Permeability	73
3.2.1 Experimental setup	73
3.2.2 Numerical determination	82
3.2.3 Results of k_r - S_w relationships	84

3.3 (Effective) Diffusivity	88
3.3.1 Determination with Wicke-Kallenbach cell	89
3.3.2 Numerical approach	93
3.3.3 Results	95
4 Counter-current Flow in Thin Porous Layers	101
4.1 Counter-current Flow Experiment	101
4.2 Comparison with Darcy-approach	105
A Gas Diffusion Media	113
A.1 Type of measuring methods	113
A.2 Material properties	116
B Algorithms for Structure Generation	125
B.1 Non-woven structures / carbon paper	127
B.2 Woven structures / carbon cloth	129
B.3 Hydrophobic coating	131
B.3.1 Parabolic between fibres	132
B.3.2 Stochastically distributed	134
B.3.3 Morphological closing	135
B.4 Error analysis	137
B.4.1 2D analysis	137
B.4.2 3D analysis	137
C Parameters and Values	141
C.1 k_r - S_w measurement	141
C.2 D_{eff} measurement	142
D Additional results	143
D.1 Capillary pressure–saturation relationship	144
D.2 Permeability	144
D.3 (Effective) Diffusivity	146
Bibliography	149