

Contents

1	Introduction and Motivation	1
2	Roughness: Fundamentals	5
2.1	Rough Surfaces	5
2.1.1	Profile Parameters	7
2.1.2	Areal Parameters	12
2.1.3	Filtering	19
2.2	Roughness Measurement Methods: State of the Art	24
2.2.1	Line-Profiling Methods	26
2.2.2	Areal-Topography Methods	28
2.2.3	Area-Integrating Methods	35
3	Light-Matter Interaction: Fundamentals	43
3.1	Speckle Basics	43
3.1.1	Speckle Effect	45
3.1.2	Speckle Statistics	45
3.1.3	Contrast	52
3.1.4	Speckle Size	54
3.2	Polarization	55
3.2.1	Stokes Parameters	56
3.2.2	Degree of Polarization	59
4	Depolarization Effects: Roughness in Sub-Micron Range	61
4.1	Theory	62
4.1.1	Fringe Contrast in Interference Microscopes	62
4.1.2	Depolarization of Rough Surfaces	65
4.1.3	Depolarization-Fringe Contrasts	66
4.1.4	Mathematical Model	71
4.1.5	Fringe Contrast in Speckle Interferometers	76
4.2	Experiments	79
4.2.1	Experimental Setup	80
4.2.2	Implementation of Depolarization Effects	84
4.2.3	Methodology	89
4.3	Results and Discussion	99
4.3.1	Depolarization-based Roughness Measurements	100
4.3.2	Extension of Validity Range	112
4.3.3	Simulations	116

4.3.4	Limitations	122
5	Summary and Outlook	125
A	Appendix	129
A.1	Derivations	129
A.1.1	Depolarization-Fringe Contrasts	129
A.1.2	Contrast-Dependent Roughness	130
A.2	List of Symbols	135
A.3	List of Abbreviations	140
A.4	List of Figures	142
A.5	List of Tables	145
A.6	Acknowledgement – Danksagung	147
	Bibliography	149
	Own Publications – Articles	173
	Own Publications – Conference Contributions	174
	Supervised Student Theses	175