
Contents

1 Introduction	1
2 General concepts and framework	5
2.1 Magnetism	6
2.1.1 Types of magnetism in matter	7
2.1.2 Magnetic energies	8
2.1.3 Magnetic domains and domain walls	12
2.2 Micromagnetism of domain walls	14
2.2.1 Domain wall static profile	14
2.2.2 Landau-Lifshitz-Gilbert equation	16
2.2.3 1D model for field-driven domain wall dynamics	18
2.2.4 Domain wall dynamics driven by field and current	22
2.2.5 Limitations of micromagnetic theory and alternative approaches	25
2.3 Elastic interfaces in disordered media	26
2.3.1 Roughness characterization	28

2.3.2	Dynamical regimes of driven interfaces	32
2.4	Magnetic domain walls as driven elastic lines	39
2.4.1	Experimental observation of creep and flow regimes	39
2.4.2	Universal creep regime	40
2.4.3	Universal depinning transition	43
2.4.4	Length scales and roughness exponents	45
2.5	Studied magnetic thin films	49
2.5.1	Rare earth - transition metal ferrimagnetic alloys	50
2.5.2	Diluted ferromagnetic semiconductors	55
2.6	Chapter summary and thesis overview	57
3	Experimental techniques	
	and studied samples	59
3.1	Magneto-optical Kerr effect imaging	60
3.1.1	Polar Kerr effect	61
3.1.2	Magneto-optical contrast	61
3.2	Polar magneto-optical Kerr effect microscope	66
3.2.1	Optical setup	66
3.2.2	Temperature control	69
3.2.3	Domain wall velocity measurement	71
3.2.4	Magnetic field pulses	73
3.2.5	Domain wall profile detection	77
3.3	Thin film of GdFeCo	79
3.3.1	Magnetic characterization	79
3.4	(Ga,Mn)(As,P)/(Ga,Mn)As bilayer	85
3.5	Chapter summary	87

4	Field-driven domain wall dynamics in a ferrimagnetic GdFeCo thin film	89
4.1	Motivation, framework and previous investigations	91
4.1.1	Thermally activated dynamics and depinning transition	91
4.1.2	Universal depinning critical exponents	93
4.2	Domain wall dynamics in a wide temperature range	94
4.2.1	General analysis of domain wall velocity curves	95
4.2.2	Domain wall dynamics above magnetic compensation	98
4.2.3	Domain wall dynamics below magnetic compensation	105
4.2.4	Temperature dependence of depinning parameters	115
4.3	Athermal depinning transition at low temperatures	117
4.3.1	Zero-temperature-like characteristics	118
4.3.2	General procedure for fitting the athermal depinning transition	119
4.3.3	Universal and non-universal depinning parameters	123
4.3.4	Critical behavior of the depinning correlation length	127
4.3.5	Universality class of magnetic domain wall depinning	134
4.4	Chapter summary and conclusions	136
5	Domain wall roughness in a ferrimagnetic GdFeCo thin film	139
5.1	Previous experimental roughness measurements	140
5.2	Statistically meaningful roughness measurement	142
5.2.1	Computing the displacement-displacement correlation function of a domain wall profile	142
5.2.2	Determining the roughness parameters and their uncertainties	144
5.2.3	Statistics of roughness parameters	146
5.2.4	Roughness parameters in the field-temperature diagram	148

5.3	Analysis in terms of crossover lengths	150
5.3.1	Structure factor with two crossovers	151
5.3.2	Larkin length and equilibrium correlation length	154
5.3.3	Depinning correlation length and structure factor amplitude	155
5.3.4	Resulting parameters and experimental crossover diagram	158
5.4	Chapter summary and conclusions	160
6	Field- and current-driven domain wall dynamics	
	in (Ga,Mn)(As,P)/(Ga,Mn)As	163
6.1	Motivation and framework	164
6.1.1	Universality class of field-driven and STT-driven domain wall motion	165
6.1.2	Combined effect of field and STT on domain wall motion	166
6.2	Methods for velocity measurements	169
6.2.1	Shape and simultaneity of applied pulses	169
6.2.2	Left and right domain wall velocities	171
6.3	Results and discussion	172
6.3.1	Balance of field- and STT-driven forces	173
6.3.2	Field-driven and STT-driven creep regimes	177
6.3.3	Combined field- and STT-driven dynamics	180
6.4	Chapter summary and conclusions	185
7	General conclusions and perspectives	187