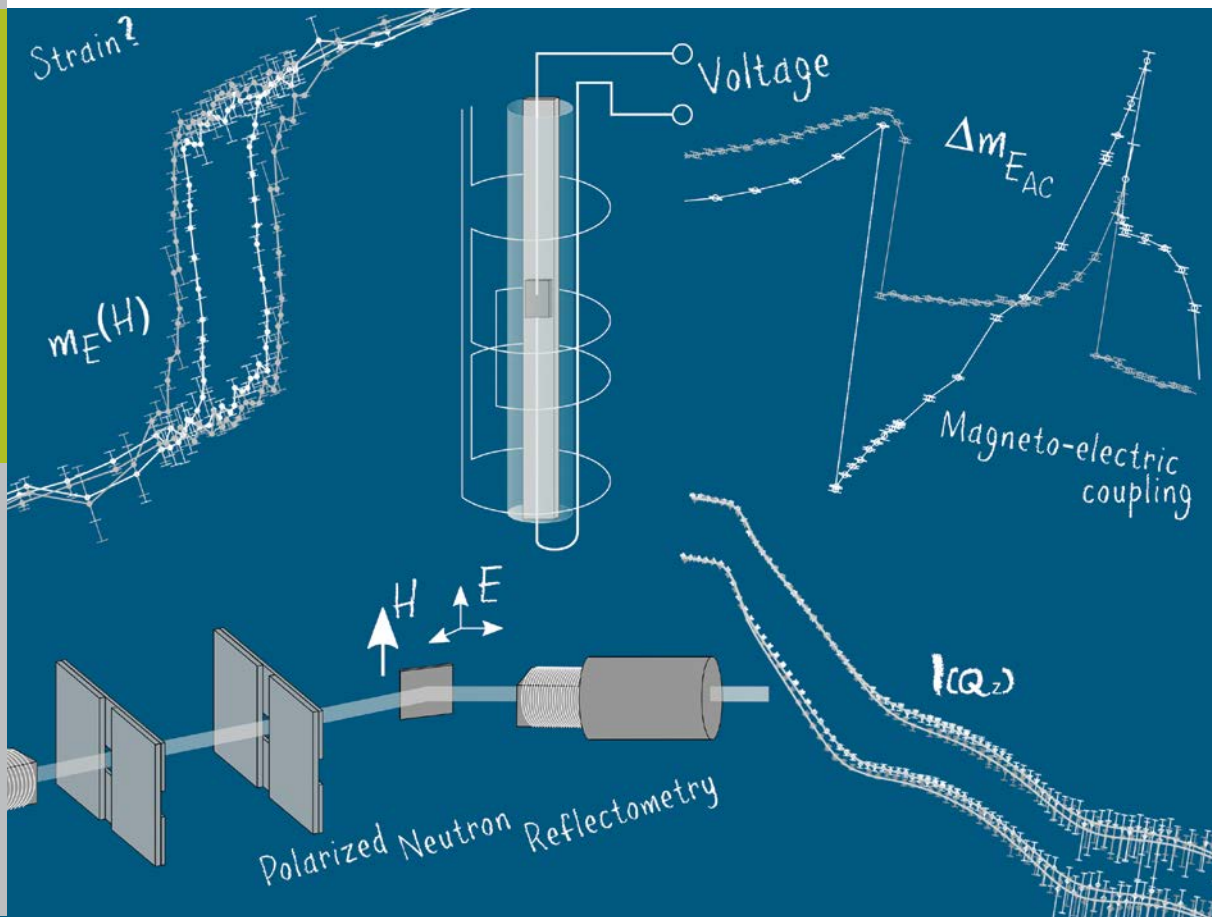


Strain and electric field mediated manipulation of magnetism in $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3/\text{BaTiO}_3$ heterostructures

Markus Schmitz



Schlüsseltechnologien /
Key Technologies
Band / Volume 129
ISBN 978-3-95806-164-4

Forschungszentrum Jülich GmbH
Jülich Centre for Neutron Science
JCNS-2

Strain and electric field mediated manipulation of magnetism in $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3/\text{BaTiO}_3$ heterostructures

Markus Schmitz

Schriften des Forschungszentrums Jülich
Reihe Schlüsseltechnologien / Key Technologies

Band / Volume 129

ISSN 1866-1807

ISBN 978-3-95806-164-4

Contents

1	Introduction	1
2	Theoretical Background	3
2.1	Perovskite Structure and Electronic Configuration	3
2.2	Magnetic Ordering in $\text{La}_{(1-x)}\text{Sr}_x\text{MnO}_3$	5
2.3	Ferroelectricity in BaTiO_3	8
2.4	Multiferroics	11
3	Scattering Theory	13
3.1	Basic Scattering Theory and Born Approximation	13
3.2	X-ray Diffraction	16
3.3	Reflectometry	17
4	Methods	23
4.1	High Oxygen Pressure Sputtering System HOPSS	23
4.2	Oxide Molecular Beam Epitaxy OMBE	25
4.3	Low Energy Electron Diffraction LEED	26
4.4	Auger Electron Spectroscopy AES	27
4.5	Reflection High Energy Electron Diffraction RHEED	28
4.6	Rutherford Backscattering Spectrometry RBS	29
4.7	X-ray Reflectometer/Diffractometer	30
4.8	Atomic Force Microscope AFM	31
4.9	SQUID-Magnetometer MPMS	32
4.10	Polarized Neutron Reflectometry PNR	35
4.10.1	Magnetic Reflectometer with High Incident Angle, MARIA	35
4.10.2	Magnetism Reflectometer MR	37
5	Sample Preparation	41
5.1	Substrate Preparation	41
5.2	$\text{La}_{0.5}\text{Sr}_{0.5}\text{MnO}_3$ on SrTiO_3	43
5.3	BaTiO_3 on SrTiO_3	47
5.4	Conclusion	53
6	Results I: $\text{La}_{0.53}\text{Sr}_{0.47}\text{MnO}_3$ on BaTiO_3	55
6.1	Structural Analysis	55
6.2	Characterization of the Macroscopic Magnetization	61

6.2.1	Temperature Dependent Magnetization	62
6.2.2	Temperature Dependent Electrical Manipulation of the Magnetization	63
6.2.3	Electrical Hysteresis Loops for Different Temperatures	64
6.2.4	Electrical Hysteresis Loops at Different Magnetic Fields	67
6.2.5	Electrical Manipulation of the Magnetization at Various Magnetic Fields	69
6.2.6	Hysteresis Loops with Applied Electric Fields	71
6.3	Analysis of the Magnetic Depth Profile	74
7	Results II:La_{0.7}Sr_{0.3}MnO₃ on BaTiO₃	81
7.1	Structural Analysis	81
7.2	Characterization of the Macroscopic Magnetization	83
7.2.1	Temperature Dependent Magnetization	83
7.2.2	Temperature Dependent Electrical Manipulation of the Magnetization	84
7.2.3	Electrical Hysteresis Loops for Different Temperatures	86
7.2.4	Electrical Manipulation of the Magnetization at Various Magnetic Fields	89
7.2.5	Hysteresis Loops with Applied Electric Fields	92
7.3	Analysis of the Magnetic Depth Profile	95
8	Discussion	101
9	Summary and Outlook	111
	Acknowledgments	113
	Bibliography	115
	List of Figures	125
	List of Tables	132
	Fit Parameter	134

Schlüsseltechnologien /
Key Technologies
Band / Volume 129
ISBN 978-3-95806-164-4

