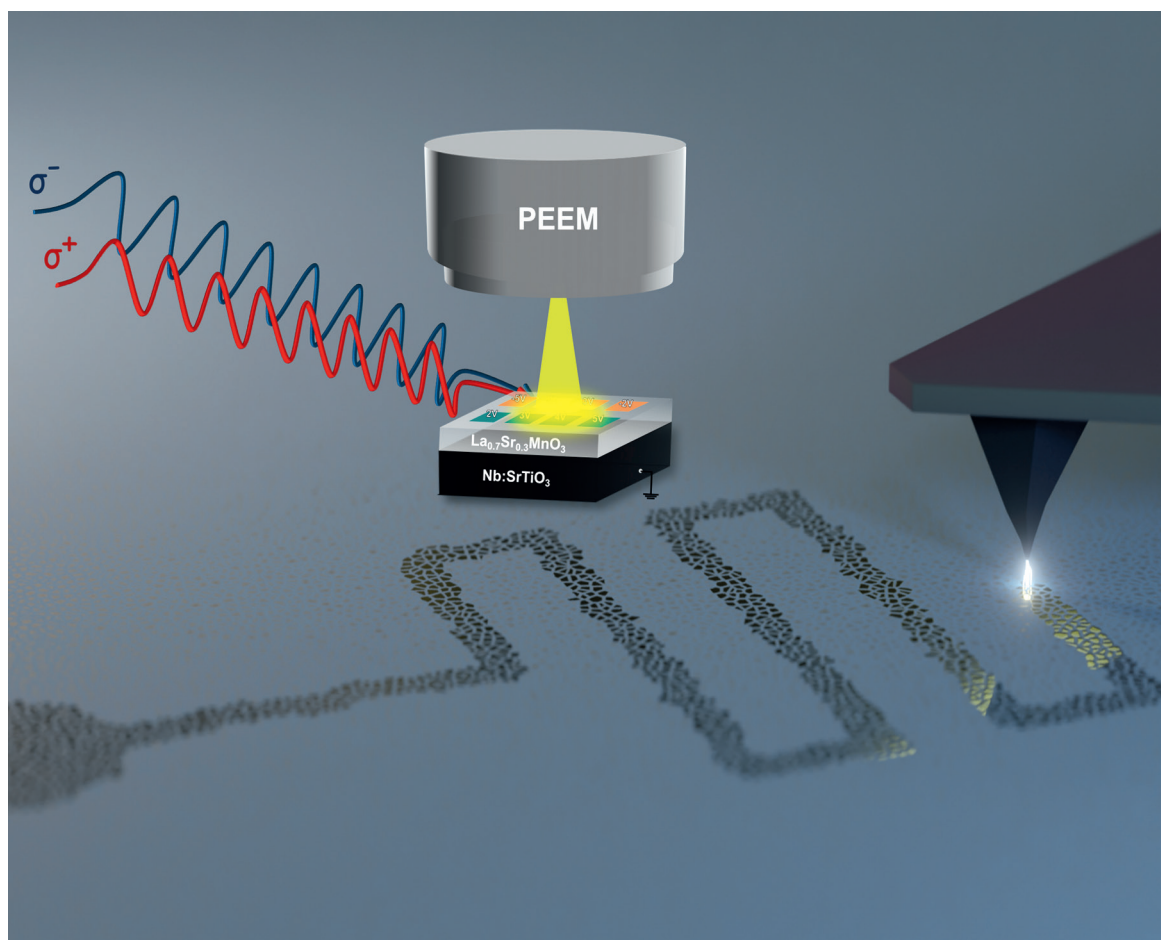




Photoemission electron microscopy of magneto-ionic effects in $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$

Marek Wilhelm

Schlüsseltechnologien / Key Technologies

Band / Volume 249

ISBN 978-3-95806-592-5

Forschungszentrum Jülich GmbH
Peter Grünberg Institut (PGI)
Elektronische Eigenschaften (PGI-6)

Photoemission electron microscopy of magneto-ionic effects in $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$

Marek Wilhelm

Schriften des Forschungszentrums Jülich
Reihe Schlüsseltechnologien / Key Technologies

Band / Volume 249

ISSN 1866-1807

ISBN 978-3-95806-592-5

Contents

I	Theoretical Background	1
1	Introduction	3
2	Resistive Switching in Complex Oxides	7
2.1	Introduction and Resistive Switching Mechanisms	7
2.2	Valence Change Model	10
2.3	Electronic Transport Across Metal/Insulator Interfaces . . .	11
3	Properties of Lanthanum Manganites	15
3.1	Introduction	15
3.2	Crystal- and Electronic Structure	16
3.2.1	Jahn-Teller-Effect	18
3.3	Magnetic Structure	20
3.3.1	Magnetic Moment in $\text{La}_{1-x}\text{Sr}_x\text{MnO}_3$	20
3.3.2	Superexchange Interaction	21
3.3.3	Double-Exchange Interaction	26
4	Photoelectron Emission Spectroscopy & Microscopy	27
4.1	Photoemission Process	28
4.2	The Photoexcitation Process - Fermi's Golden Rule	30
4.3	Electron Spectroscopy for Chemical Analysis (ESCA)	31
4.3.1	X-Ray Photoemission Spectroscopy (XPS)	32
4.3.2	X-Ray Absorption Spectroscopy (XAS)	33
4.4	Spin-Orbit-Coupling (SOC)	34
4.5	X-Ray Magnetic Circular Dichroism (XMCD)	35
4.6	Photoemission Electron Microscopy (PEEM)	37
4.7	Synchrotron Radiation Photon Source	40

II Experimental Methods 43

5	Sample Preparation	45
5.1	Substrate Termination	45
5.2	Pulsed Laser Deposition	46
5.3	Reflection High Energy Electron Diffraction	48
6	Characterization Methods	51
6.1	Atomic Force Microscopy (AFM)	51
6.2	X-Ray Diffraction (XRD)	52
6.3	Vibrating Sample Magnetometry (VSM)	53

III Experimental Results 57

7	Growth and Characterization of $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ Thin Films	59
7.1	PLD Growth Recipe for LSMO	59
7.2	Structure and Morphology	60
7.3	Electronic Structure	62
7.4	Magnetic Properties	64
	7.4.1 Vibrating Sample Magnetometry (VSM)	64
	7.4.2 X-Ray Magnetic Circular Dichroism	67
	7.4.3 Conclusion	70
8	Voltage-Driven Modification of Chemical and Physical Properties in $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ Thin Films	73
8.1	Resistive Switching in $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$	73
	8.1.1 Voltage Sweep Measurements	73
	8.1.2 Summary	77
8.2	PEEM Study of the Magneto-Ionic Effect in $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$	78
	8.2.1 Electric Field Modification by LC-AFM	78
	8.2.2 Chemical Fingerprint of Electrically Modified $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_{3-\delta}$	81
	8.2.3 Magnetic Fingerprint	88
	8.2.4 Brownmillerite Phase: Structural Phase Transition in $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_{3-\delta}$	91
9	Summary and Conclusions	99

A	Reciprocal Space Map (RSM)	103
B	Magnetic Characterization of varying LSMO Thin Film Thicknesses	105
C	Principal Component Analysis	109
	Bibliography	115

Schlüsseltechnologien / Key Technologies
Band / Volume 249
ISBN 978-3-95806-592-5