



Submolecular imaging with single particle atomic force sensors

Georgy Kichin

Forschungszentrum Jülich GmbH
Peter Grünberg Institut (PGI)
Functional Nanostructures at Surfaces (PGI-3)

Submolecular imaging with single particle atomic force sensors

Georgy Kichin

Schriften des Forschungszentrums Jülich
Reihe Schlüsseltechnologien / Key Technologies

Band / Volume 87

ISSN 1866-1807

ISBN 978-3-89336-976-8

Contents

List of Acronyms	9
Introduction	11
1 Theory of measurements	15
1.1 STM	15
1.1.1 Bardeen approach	17
1.1.2 Tersoff-Hamann theory	18
1.1.3 Scanning Tunnelling Spectroscopy	19
1.1.4 STM microscope	20
1.2 IETS	21
1.3 AFM	22
1.4 AFM STM simultaneous measurements	25
1.5 Scanning tunnelling hydrogenmicroscopy	26
2 Experiment	29
2.1 PTCDA	29
2.2 PTCDA/Au(111)	29
2.3 Sample preparation	31
2.4 PTCDA deposition	32
2.5 Gas deposition	32
2.6 Tip preparation	33
2.6.1 Tip for STM sensor	33
2.6.2 Tip for AFM sensor	34
3 A single particle as a sensor	35
3.1 Introduction	35
3.2 Experiment	36
3.2.1 Xenon	37
3.2.2 Carbon monoxide	42
3.2.3 Methane	46

3.3	Discussion	48
3.4	Conclusions	52
4	Calibration of the atomic-force sensor	55
4.1	Introduction	55
4.2	Experiment	57
4.3	Discussion	62
4.4	Conclusions	65
5	TLS surface scanning microscopy	67
5.1	Introduction	67
5.2	Experiment	68
5.3	Two level systems	69
5.4	Experimental results	72
5.4.1	Lateral dependence of conductance spectra	72
5.4.2	Bias dependence of the STHM contrast	75
5.5	Reconstruction of the D ₂ -surface potential	78
5.5.1	Force-field model	78
5.5.2	Energy maps	81
5.5.3	Displacement of D ₂ in the junction	85
5.5.4	PTCDA/Ag(110)	90
5.6	Conclusions	91
6	Summary and Outlook	95
6.1	Main results of the work	95
6.2	Future development	96
Appendix		99
Program code		99
Bibliography		119

Schlüsseltechnologien / Key Technologies
Band / Volume 87
ISBN 978-3-89336-976-8

