



Universiteit
Leiden
The Netherlands

Platinum electrochemistry through a magnifying glass

Jacobse, L.

Citation

Jacobse, L. (2018, November 29). *Platinum electrochemistry through a magnifying glass*. Retrieved from <https://hdl.handle.net/1887/67104>

Version: Not Applicable (or Unknown)

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/67104>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/67104> holds various files of this Leiden University dissertation.

Author: Jacobse, L.

Title: Platinum electrochemistry through a magnifying glass

Issue Date: 2018-11-29

Platinum Electrochemistry *through a magnifying glass*

Proefschrift

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van Rector Magnificus prof. mr. C.J.J.M. Stolker
volgens besluit van het College voor Promoties
te verdedigen op donderdag 29 november 2018
klokke 10:00

door

Leon Jacobse

geboren te Rotterdam in 1990

Promotiecomissie:

Promotor: Prof. dr. M.T.M. Koper

Co-promotor: Dr. M.J. Rost

Overige leden: Prof. dr. J.M. Feliu (University of Alicante)
Prof. dr. rer. nat. A. Stierle (DESY NanoLab)
Dr. I.M.N. Groot
Prof. dr. J.M. van Ruitenbeek
Prof. dr. H.S. Overkleef

ISBN: 978-94-92679-62-8

Printing: Print Service Ede

Cover illustration: Alexandra Hunts (www.alexandrahunts.com)

*Avoid the crowd. Do your own thinking independently.
Be the chess player, not the chess piece.*

Ralph Charell

Table of Contents

1	Introduction	1
1.1	Electrochemistry	2
1.2	Model catalysts	4
1.3	Electrochemical scanning probe microscopy	6
1.4	Outline of this thesis	8
2	Electrochemical nanoisland growth on Pt(111)	11
2.1	Electrochemical measurements	13
2.2	<i>in situ</i> EC-STM	14
2.3	Quantitative roughness analysis	19
2.4	Conclusions	25
3	Identifying surface sites during the roughening of Pt(111)	29
3.1	Electrochemical measurements	31
3.2	EC-STM site densities	34
3.3	Correlating site densities to reactivity	38
3.4	Conclusions	45
4	Voltammetric SECCM: dynamic imaging of hydrazine oxidation	49
4.1	Voltammetric SECCM	51
4.2	Hydrazine oxidation at Pt electrodes	54
4.3	Voltammetric SECCM imaging	56
4.4	Hydrazine oxidation in air	62
4.5	Conclusions	65
5	The reactivity of platinum microelectrodes	69
5.1	Electrode characterization	71
5.2	Catalytic reactivity	74
5.3	UME vs. macroelectrode	79
5.4	Conclusions	81
A	EC-STM methods and general data processing	85
A.1	Methods	85
A.2	EC-STM images	87
A.3	Cyclic voltammetry	87

B	Roughening analysis of Pt(111)	91
B.1	Vacancy evolution	91
B.2	Scaling analysis	91
B.3	Correlation coefficient	95
C	Surface site identification of roughened Pt(111)	97
C.1	Average nanoisland	97
C.2	Structural fits	99
C.3	Site densities	100
C.4	CV fits	108
D	Platinum nanoisland structures	109
E	Details on SECCM experiments	111
E.1	Methods	111
E.2	Cyclic voltammetry	112
E.3	Droplet residues	112
E.4	Quantitative multimicroscopy	114
F	UME methods	117
	Summary and Outlook	121
	Samenvatting	127
	List of publications	132
	Curriculum vitae	134