Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory

Title

Fabrication, characterization and reaction studies of nanofabricated platinum model catalysts

Permalink https://escholarship.org/uc/item/9qq4x0dq

Author

Zhu, Ji

Publication Date 2003-08-15

Acknowledgement

I would like to express my deep appreciation for Prof. Gabor A. Somorjai for his willingness to take me into his research group and for the wonderful opportunity and passionate guidance he gave me during the five-year training to be a Ph.D. His enthusiasm and interest for science are contagious. I have learned not only scientific techniques from him, but also more importantly, the method of scientific thinking, how to identify a research problem, how to form and carry out a research plan and how to get results. What I have learned at Berkeley will greatly benefit my future careers.

Berkeley has a lot to offer for hungry young minds. The close tie of a world-class research university and a famous national lab easily creates a stimulating research environment. Teaching assignments, a variety of classes and seminars offered by UC Berkeley provide the perfect attraction aside research. The deadly combination of California's sunny weather and beautiful sight of the golden bridge and the Pacific Ocean at marina certainly makes doing research at Berkeley a struggle. The diversity and high intellectual level of the city proudly offers another distraction. No wonder there is always future work to do. It is a wonderful place to be. I am grateful to be able to spend time here.

I was also lucky to be able to associate myself with the talented and hard working members of past, present and future Somorjai group members. Dr. Aaron Eppler, my mentor in the laboratory, taught me everything I knew about UHV, surface science and catalysis. Two other Nano clan members, Mr. Jeff Grunes, Mr. Anthony Contreras are working towards their Ph.D.s now. Wish them best luck in their research. I will always

cherish the time we spent together working on various projects. I would also like to thank Aric Opdahl, Peilin Chen, Steve Baldelli, Keng Chou, Jamie Kim, Seong Kim, Zhan Chen, Yong Chen, Chen Wang and all other members in the Somorjai group. I am indebted to Prof. Jeffrey Bokor and Yang-Kyu Choi for their kind help in teaching me how to work in Microlab. I also want to thank Dr. Eric Anderson for his work and contribution in the electron beam lithography.

I am thankful to the excellent work of Somorjai secretaries, most notably Inger Coble, to keep the project alive and financially healthy. I am also indebted to the support from electronic, pump and machine shops both at chemistry department and at Lawrence Berkeley National Laboratory to keep every equipment and electronics working. The facilities in National Center for Electron Microscopy provide loads of data used in this thesis. Their contribution is also duly noted.

Finally, I want to thank the friends I made at Berkeley. They constantly remind me a graduate student should also have a life.

Table of Contents

Chapter 1	Introduction	1
Chapter 2	Experimental Techniques	
empter 2	2.1 Ultra-high Vacuum and Surface Science Techniques	7
	2.1.1 Auger Electron Spectroscopy	
	2.1.2 Temperature Programmed Desorption	
	2.1.3 X-ray Photoelectron Spectroscopy	
	2.2 Microscopy	
	2.2.1 Atomic Force Microscopy	
	2.2.2 Scanning Electron Microscopy	
	2.3 Electron Beam Lithography	
Chapter 3	Fabrication, Characterization and Adhesion Studies of Pt/Al ₂ Electron Beam Lithography	•
	3.1 Introduction	
	3.2 Experimental	
	3.3 Results and Discussion	
	3.3.1 Characterization	
	3.3.2 Adhesion	
	3.4 Conclusion	47
Chapter 4	Catalyst Activation and Ethylene Hydrogenation on Pt/Al ₂ O ₃ Catalyst Made by Electron Beam Lithography	Model
	4.1 Introduction	55
	4.2 Experimental	
	4.3 Results and Discussion	
	4.3.1 Characterization of the Pt Nanoparticle Arrays	
	4.3.2 NO ₂ Cleaning	
	4.3.3 Ethylene Hydrogenation Reaction Rate Studies	
	4.3.4 CO Inhibited Ethylene Hydrogenation Reaction	
	Rate Studies	65
4.4	Conclusion	
Chapter 5	The Formation of Platinum Silicide on Pt Foil	
•	5.1 Introduction	
	5.2 Experimental	82
	5.3 Results and Discussion	
	5.3.1 Silicon Deposition on Pt Foil	
	5.3.2 Chemical Stability of Silicide on Pt Foil	
	5.4 Conclusion	86

Chapter 6	Novel Nanofabrication Methods	
	6.1 Introduction	92
	6.2 Size Reduction Lithography	
	6.2.1 Scheme of Size Reduction Lithography	97
	6.2.2 Experimental Details	
	6.3 Nanoimprint Lithography	
	6.3.1 Scheme of Nanoimprint Lithography	102
	6.3.2 Experimental Details	102
	6.4 Conclusion	107
Chapter 7	Future Directions	125