

**ANDRZEJ WIECKOWSKI**  
*Curriculum Vitae, abbreviated*

**Professor of Chemistry, University of Illinois at Urbana-Champaign**

**The North American Editor for *Electrochimica Acta***

(The official journal of the International Society of Electrochemistry)

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**KEY RESEARCH CONCENTRATION AREAS**

**(1) Catalysis and Fuel Cells**

Co-inventor (with R. Masel) the direct oxidation formic acid fuel cell (DFAFC)

Polymer Electrolyte Fuel Cells (PEM) fundamentals

Anode and cathode catalysis by transition metal elements

**(2) Electrochemical Surface Science**

Electrocatalysis (spectroscopy, imaging), single crystals, nanostructured surfaces and materials

**(3) Methodology**

Vibrational surface spectroscopies, metal/surface NMR with electrochemical adsorbates, BB-SFG with electrochemical adsorbates, methods of electroanalysis and surface science, radioactive labeling

**EDUCATION**

University of California at Santa Barbara, USA, postdoctoral study, **1983/85**

University of Warsaw, Warsaw, Poland, PhD/DSc (habilitation) **1981**

**POSITIONS HELD**

Professor of Chemistry, University of Illinois at Urbana-Champaign, **1996-present**

Assistant/Associate Professor, University of Illinois at Urbana-Champaign, **1985-1996**

Principal Investigator: Frederic Seitz Materials Research Laboratory (UIUC), **1990-2005**

North American Editor of *Electrochimica Acta* (Elsevier), **2002-present**

Professor of Chemical Sciences (honorary) in Poland, **2003-present**

**MAIN AWARDS/HONORS**

Fellow of ISE (the International Society of Electrochemistry), **2009**

Gold Medal of the International Society of Electrochemistry (ISE), **2007**

Fellow of ECS (The Electrochemical Society), **2007**

Invited lectureship in Japan: **2004**

The David C. Graham Award of the Electrochemical Society, **2003**

Professor of Chemical Sciences (honorary), Poland, **2003**

North American Editor of *Electrochimica Acta*, **2002-present**

Procter & Gamble Award Lecture, P&G and University of Cincinnati, Cincinnati, OH, **1999**

Jacques Tacussel Prize of the International Society of Electrochemistry, **1998**

The US Department of Energy Prize for Outstanding Scientific Accomplishment in Materials Chemistry, **1992**

## **OTHER RECENT RECOGNITIONS**

The International Advisory Board, Wiley (*ChemSusChem*), 2009 - present.

The International Advisory Board, Elsevier (Advances in Fuel Cell Book Series), 2005 - present.

Plenary lecturer, the inaugural Hougen Symposium on Fuel Cells, Madison, Wisconsin, USA, September 17 - 18, 2003.

Faraday Discussion: "The Dynamic Electrode Surface", co-organizer, Berlin, April 2002.

## **HIGHLIGHTS**

Co-inventor, patenting etc. (with Prof. R. Masel) of the direct oxidation formic acid fuel cell (DFAFC)

Development of electrochemical NMR spectroscopy (EC-NMR)

Development of the radioactive labeling method with smooth and single crystal electrodes

## **ACCOMPLISHMENTS**

### **Fuel Cells**

Co-inventor of the direct oxidation formic acid fuel cell (DFAFC)

New catalyst development: Ru/Pt and Se/Ru/Me via the method of spontaneous deposition (developed at Urbana-Champaign)

### **Research methodology**

- Broad-band sum frequency generation (BB-SFG) for research in electrochemical surface science (with Professor D. D. Klott)
- Electrochemical NMR spectroscopy (EC-NMR)
- Core level electron energy spectroscopy (CL-EELS in UHV for electrochemistry)
- Radioactive labeling method for characterization of adsorption on well-defined, single crystal electrodes

### **New science**

- Co-adsorbed porphyrines
- UPD and noble/metal on noble metal catalysts studies by XPS experiment and theory
- First direct observation of surface diffusion at electrodes (via EC-NMR)
- First observation of reacting intermediates in a fuel cell reaction on well-defined electrodes by BB-SFG
- Surface structure in electrochemistry at a DOS level by the use of EC-NMR
- Pt/Ru, Pt/Os, Pt/Pd methanol, formic acid oxidation electrocatalysis: structure and reactivity (first studies using single crystal and nano-surfaces as substrate for alloy/ternary catalysts)
- Pioneering work with <sup>13</sup>C-adsorbates on nanoparticle platinum electrodes by EC-NMR
- Surface radiochemistry of ions and molecules on single crystal and nanoscale electrodes
- First electrochemical and vacuum (UHV) characterization of rhodium single crystal electrodes
- LEED/voltammetry of CO on Pt single crystal electrodes

- Studies of deposition and corrosion inhibition: electrochemistry, radiochemistry, UHV approach
- Data for Monte Carlo calculations (with P. A. Rikvold), electrochemical phase transitions

### Paper citations

- Over 10,000 citations and H-index = 56

### **FUNDING (current funding underlined)**

AFOSR; NSF (DMR/MRL); NSF (CTS, SBiR), NSF (CHE); (DARPA, EC-NMR instrumental grant); DoE (BES, EERE), ARO, ARO MURI, the Toyota Research Center grant

### **LIST of PUBLICATIONS**

1. N. Cheng and A. Wieckowski, "Oxygen Reduction Reaction by Metal Porphyrins for Fuel Cells", *Electrocatalysis*, submitted.
2. J. Jiang and A. Wieckowski, "Accelerated CO Electrooxidation via a Formate Pathway in Intermediate Temperature Alkaline Media", *Chemical Communications*, submitted.
3. M. Neurock and A. Wieckowski, "Contrast and Synergy between Electrocatalysis and Heterogeneous Catalysis," *Advances in Physical Chemistry*, in press.
4. R. Kutz, B. Braunschweig, P. Mukherjee, D. D. Dlott and A. Wieckowski, "Study of Ethanol Electrooxidation in Alkaline Electrolytes with Isotope Labels and Sum-Frequency Generation", *Phys. Chem. Letters*, **2**, 2236-2240 (2011).
5. B. Braunschweig, P. Mukherjee, D. D. Dlott and A. Wieckowski, "Real-Time Investigations of Pt(111) Surface Transformations in Sulfuric Acid Solutions", *JACS Communication*, **132**, 14036-14038 (2010).
6. R. B. Kutz, B. Braunschweig, P. Mukherjee, R. L. Behrens, D.D. Dlott; A. Wieckowski, Reaction pathways of ethanol electrooxidation on polycrystalline platinum catalysts in acidic electrolytes, *J. Catalysis* **278**, 181-188 (2011).
7. F. R., Brushett, H.T., Duong, J. W. D. Ng, R. L. Behrens, A. Wieckowski, P. J. A. Kenis, Investigation of Pt, Pt<sub>3</sub>Co, and Pt<sub>3</sub>Co/Mo Cathodes for the ORR in a Microfluidic H<sub>2</sub>/O<sub>2</sub> Fuel Cell, *J. Electrochem. Soc.*, **157**, B837-B845 (2010).
8. B. Braunschweig, P. Mukherjee, R. Kutz, A. Wieckowski and D. D. Dlott, "Spectro-electrochemistry of Acetate Chemisorption on Au and Pt Surfaces: Molecular Structure Effects." *J. Chem. Phys.*, **133**, 234702; 1-8 (2010).
9. S. N. S. Goubert-Renaudin, X. Zhu and A. Wieckowski, "Synthesis and Characterization of Carbon-Supported Transition Metal Oxide Nanoparticles - Cobalt Porphyrin as Catalysts for Electroreduction of Oxygen in Acids", *Electrochem. Communications*, **12**, 1457-1461 (2010).
10. R. L. Behrens, A. Lagutchev, D. D. Dlott and A. Wieckowski, "Broad-Band Sum Frequency Generation Study of Formic Acid Chemisorption on a Pt(100) Electrode", *J. Electroanal. Chem.*, **649**, 32-36 (2010).
11. C. J. Corcoran, H. Tavassol, M. A. Rigsby, P. S. Bagus and A. Wieckowski, Application of XPS to Study Electrocatalysts for Fuel Cells, *J. Power Sources* **195**, 7856-7879 (2010).

12. D. M. Anjos, M. A. Rigsby and A. Wieckowski, Underpotential Deposition of Copper and Silver on Single Crystal Surfaces of Rhodium, *J. Electroanal. Chem.*, **639**, 8-14 (2010).
13. P. S. Bagus, C. Woll and A. Wieckowski, "Dependence of Surface Properties on Adsorbate-Substrate Distance: Work Function Changes and Binding Energy Shifts for I/Pt(111)", *Surface Science*, **603**, 273-283 (2009).
14. J.-F. Maxime Guinel, A. Bonakdarpour, B. Wang, P. K. Babu, F. Ernst, N. Ramaswamy, S. Mukerjee and A. Wieckowski, "Carbon-Supported, Selenium-Modified Ruthenium– Molybdenum Catalysts for Oxygen Reduction in Acidic Media", *ChemSusChem*, **2**, 658-664 (2009).
15. G. Q. Lu, A. Lagutchev, T. Takeshita, R. L. Behrens, D. D. Dlott and A. Wieckowski, in: "Fuel Cell Catalysis: A Surface Science Approach", M. Koper (Ed.), "Broad-Band Sum Frequency Generation Studies of Surface Intermediates Involved in Fuel Cell Electrocatalysis", John Wiley & Sons, Inc., 2009 (pp. 375-410).
16. C. Delacote, A. Bonakdarpour, C.M. Johnston, P. Zelenay, A. Wieckowski, "Aqueous-based Synthesis of Ruthenium-Selenium Catalyst for Oxygen Reduction Reaction", *Faraday Discussions*, **140**, 269-281 (2008).
17. M. Neurock, M. Janik and A. Wieckowski "A First Principles Comparison of the Mechanism and Site Requirements for the Electrocatalytic Oxidation of Methanol and Formic Acid over Pt", *Faraday Discussions*, **140**, 363-378 (2008).
18. P. K. Babu, J.-H. Chung, E. Oldfield and A. Wieckowski, "Molecular Motions on Nanoparticle Surfaces: CO Surface Diffusion on Platinum by Electrochemical NMR", *Electrochimica Acta* **53**, 6672-6679 (2008).
19. M.A. Rigsby, W.-P. Zhou, A. Lewera, H.T. Duong, P.S. Bagus, W. Jaegermann, R. Hunger, and A. Wieckowski, "The Experiment and Theory of Fuel Cell Catalysis: Methanol and Formic Acid Decomposition on Nanoparticle Pt/Ru", *J. Phys. Chem. C* **112**, 15595-15601 (2008).
20. A. Wieckowski, "New Concepts in Chemistry and Engineering of Low Temperature Fuel Cells"; *Bulletin of Polish Hydrogen and Fuel Cell Association* ([www.hydrogen.edu.pl](http://www.hydrogen.edu.pl)), **3**, 31-42 (2008).
21. L. Gancs, T. Kobayashi, M. Debe, R. Atanasoski and A. Wieckowski, "Crystallographic Characteristics of Nanostructured Thin Film Fuel Cell Electrocatalysts. A HRTEM Study", *Chemistry of Materials*, **20**, 2444-2454 (2008).
22. A. Bonakdarpour, C. Delacote, R. Yang, A. Wieckowski and J.R. Dahn, Loading of Se/Ru/C "Electrocatalyst on a Rotating Ring-Disk Electrode and the Loading Impact on a H<sub>2</sub>O<sub>2</sub> Release during Oxygen Reduction Reaction", *Electrochemistry Communication*, **10**, 611-615 (2008).
23. T. Zawodzinski, A. Wieckowski, S. Mukerjee, M. Neurock, "Integrated theoretical and experimental studies of fuel cell electrocatalysts". *Electrochemical Society Interface*, **16**, 37-41, (2007).
24. J. S. Spendelow, Q. Xu, J. D. Goodpaster, P. J. A. Kenis and A. Wieckowski, "The Role of Surface Defects in CO Oxidation, Methanol Oxidation, and Oxygen Reduction on Pt(111)", *J. Electrochem. Soc.*, **154**, F238-F242, (2007).
25. P. K. Babu, A. Lewera, J.-H. Chung, R. Hunger, W. Jaegermann, N. Alonso-Vante, A. Wieckowski and E. Oldfield, "Selenium Becomes Metallic in Ru-Se Fuel Cell Catalysts: An EC-NMR and XPS Investigation", *J. Am. Chem. Soc.*, **129**, 15140-15141 (2007).
26. J. Inukai, D. Cao, A. Wieckowski, K.-C. Chang, A. Menzel, V. Komanicky, and H. You, "In-situ Synchrotron X-ray Spectroscopy of Ruthenium Nanoparticles Modified with Selenium for an Oxygen Reduction Reaction", *J. Phys. Chem. C*, **111**, 16889-16894 (2007).

27. A. Lewera, W.-P. Zhou, R. Hunger, W. Jaegermann, A. Wieckowski, S. Yockel, and P.S. Bagus, "Core-Level Binding Energy Shifts in Pt-Ru Nanoparticles: A Puzzle Resolved", *Chem. Phys. Letters*, **447**, 39-43 (2007).
28. I. Dabo, A. Wieckowski and N. Marzari, "Vibrational Recognition of Adsorption Sites for CO on Platinum and Platinum-Ruthenium Surfaces", *J. Am. Chem. Soc.*, **129**, 11045-11052 (2007).
29. W. P. Zhou, A. Lewera, P.S. Bagus, A. Wieckowski, "Electrochemical and Electronic Properties of Pt Deposits on Ru(0001)", *J. Phys. Chem. C*, **111**, 13490-13496 (2007).
30. H. T. Duong, M.A. Rigsby, W.P. Zhou and A. Wieckowski, "Oxygen Reduction Catalysis of the Pt<sub>3</sub>Co Alloy in Alkaline and Acidic Media Studied by X-ray Photoelectron Spectroscopy and Electrochemical Methods", *J. Phys. Chem. C*, **111**, 13460-13465 (2007).
31. J. S. Spendelow and A. Wieckowski, "Electrocatalysis of Oxygen Reduction and Small Alcohol Oxidation in Alkaline Media", *Phys. Chem. Chem. Phys.*, **9**, 2654-2675, 2007.
32. T. Kobayashi, P.K. Babu, J.-H. Chung, E. Oldfield and A. Wieckowski, "Coverage Dependence of CO Diffusion on Pt Nanoparticle Surfaces: an EC-NMR Study", *J. Phys. Chem. C*, **111**, 7078 -7083 (2007).
33. A. Lewera, J. Inukai, W.P. Zhou, D. Cao, H.T. Duong, N. Alonso-Vante and A. Wieckowski, "Chalcogenide Oxygen Reduction Reaction Catalysis: X-ray Photoelectron Spectroscopy with Ru, Ru/Se and Ru/S Samples Emerged from Aqueous Media", *Electrochimica Acta*, **52**, 5759-5765 (2007).
34. A. Kowal, M. Skompska and A. Wieckowski. Preface. The Krakow special issue of *Electrochimica Acta*. *Electrochimica Acta*, **52**, 5509-5511 (2007).
35. J. S. Spendelow, J.D. Goodpaster, P.J.A. Kenis, and A. Wieckowski, "Methanol Dehydrogenation and Oxidation on Pt(111) in Alkaline Solutions", *Langmuir*, **22**, 10457-10464 (2006).
36. A. Lagutchev, G.Q. Lu, T. Takeshita, D.D. Dlott and A. Wieckowski, "Vibrational Sum Frequency Generation Studies of the (2x2)->(root 19x root 19) Phase Transition of CO on Pt(111) Electrodes", *J. Chem. Phys.* **125**, 154705/1-10 (2006).
37. H. Yano, J. Inukai, H. Uchida, M. Watanabe, P.K. Babu, T. Kobayashi, J.-H. Chung, E. Oldfield and A. Wieckowski, "Particle-size Effect of Nanoscale Platinum Catalysts in Oxygen Reduction Reaction: An Electrochemical and 195Pt EC-NMR Study", *Phys. Chem. Chem. Phys.*, **8**, 4932-4939 (2006).
38. W. P. Zhou, A. Lewera, R. Larsen, R.I. Masel, P.S. Bagus, and A. Wieckowski, "Size Effects in Electronic and Catalytic Properties of Unsupported Palladium Nanoparticles in Electrooxidation of Formic Acid", *J. Phys. Chem. B.*, **110**, 13393-13398 (2006).
39. C. M. Johnston, S. Strbac, A. Lewera, E. Sibert, W. Zhou, and A. Wieckowski, "Characterization and Methanol Electrooxidation Studies of Pt(111)/Os Surfaces Prepared by Spontaneous Deposition", *Langmuir*, **22**, 8229-8240 (2006).
40. J. S. Spendelow, P.K. Babu, A. Wieckowski, "Electrocatalytic Oxidation of Carbon Monoxide and Methanol on Platinum Surfaces Decorated with Ruthenium", *Curr. Opinion Solid St. and Mat. Science*, **9**, 37-48 (2006).
41. S. Strbac, C. Johnston, A. Wieckowski, "Decorated Ru/Au(111) and Os/Au(111) surfaces: An in situ STM and electrochemistry study" *Russian Journal of Electrochemistry*, **42**, 1244-1250 (2006).

42. J. S. Spendelow, J.D. Goodpaster, P.J.A. Kenis, and A. Wieckowski, "The Mechanism of CO Oxidation on Pt(111) in Alkaline Media" *J. Phys. Chem. B*, **110**, 9545-9555 (2006).
43. D. Cao and A. Wieckowski (UIUC); J. Inukai (Tohoku); N. Alonso-Vante (Poitiers), "Oxygen Reduction Reaction on Ruthenium and Rhodium Nanoparticles Modified with Selenium and Sulfur" *J. Electrochem. Soc.*, **153**, A869-A874 (2006).
44. H. Imai, P.K. Babu, E. Oldfield, A. Wieckowski, D. Kasuya, T. Azami, Y. Shimakawa, M. Yudasaka, Y. Kubo, and S. Iijima, "<sup>13</sup>C NMR Spectroscopy of Carbon Nanohorns", *Physical Review B* **73**, 125405 (1-7) (2006).
45. P.S. Bagus, A. Wieckowski, and H. Freund, "Initial and Final State Contributions to Binding-Energy Shifts Due to Lattice Strain: Validation of Auger Parameter Analyses", *Chem. Phys. Lett.*, **420**, 42-46 (2006).
46. A. Lewera, W.P. Zhou, C. Vericat, J.H. Chung, R. Haasch and A. Wieckowski, P.S. Bagus, "XPS and Reactivity Study of Bimetallic Nanoparticles Containing Ru and Pt Supported on a Gold Disk", *Electrochimica Acta*, **51**, 3950-3956 (2006).
47. C. M. Johnston, S. Strbac and A. Wieckowski, "In situ STM Study of Au(111)/Os Bimetallic Surfaces: Spontaneous Deposition and Electrochemical Dissolution", *Langmuir*, **21**, 9610-9617 (2005).
48. M.S. McGovern, P. Waszczuk, and A. Wieckowski, "Stability of Carbon Monoxide Adsorbed on Nanoparticle Pt and Pt/Ru Electrodes in Sulfuric Acid Media", *Electrochimica Acta*, **51**, 1194-1198 (2006).
49. T. Kobayashi, P.K. Babu, L. Gancs, J.-H. Chung, E. Oldfield and A. Wieckowski, "An NMR Determination of CO Diffusion on Platinum Electrodes", *J. Am. Chem. Soc.*, **127**, 14164-14165 (2005).
50. P. K. Babu, H.-S. Kim, S.T. Kuk, J.H. Chung, E. Oldfield, A. Wieckowski (UIUC) and E.S. Smotkin (UPR), "Activation of Nanoparticle Pt/Ru Fuel Cell Catalysts by Heat Treatment: A <sup>195</sup>Pt NMR and Electrochemical Study", *J. Phys. Chem. B.*, **109**, 17192-17196 (2005).
51. F. Maillard, G.-Q. Lu, A. Wieckowski and U. Stimming, "Ru-Decorated Pt Surfaces as Model Fuel Cell Electrocatalysts for CO Electrooxidation", *J. Phys. Chem. B* feature article, **109**, 16230-16243 (2005).
52. E. R. Choban, J.S. Spendelow, L. Gancs, A. Wieckowski, P.J.A. Kenis, "Membraneless Laminar Flow-Based Micro Fuel Cells Operating in Alkaline, Acidic, and Acidic/Alkaline Media", *Electrochimica Acta*, **50**, 5390-5398, 2005.
53. G. Q. Lu, A. Lagoutchev, D.D. Dlott and A. Wieckowski, "Quantitative Vibrational Sum-Frequency Generation Spectroscopy of Thin Layer Electrochemistry: CO on a Pt Electrode", *Surface Science*, **585**, 3-16 (2005).
54. D. Cao, G.-Q. Lu, A. Wieckowski (UIUC); S.A. Wasileski and M. Neurock (UVA), "Mechanisms of Methanol Decomposition on Platinum: A Combined Experimental and Ab Initio Approach", *J. Phys. Chem. B.*, **109**, 11622-11633 (2005).
55. P. K. Babu, J.-H. Chung, S.T. Kuk, T. Kobayashi, E. Oldfield and A. Wieckowski, "Metallic Nature and Surface Diffusion of CO Adsorbed on Ru Nanoparticles in Aqueous Media: A <sup>13</sup>C NMR Study", *J. Phys. Chem. B*, **109**, 2474-2477 (2005).

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58. Cover Page, invited article; J.S. Spendelow, A. Wieckowski, "Noble Metal Decoration of Single Crystal Platinum Surfaces to Create Well-Defined Bimetallic Electrocatalysts", *Phys. Chem. Chem. Phys.*, **6**, 5094-5118 (2004).
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65. M. Zhao, C. Rice, R. I. Masel, P. Waszczuk, and A. Wieckowski, "Kinetic Study of Electrooxidation of Formic Acid on Spontaneously-Deposited Pt/Pd Nanoparticles. CO Tolerant Fuel Cell Chemistry", *J. Electrochem. Soc.*, **151**, A131-A136 (2004).
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